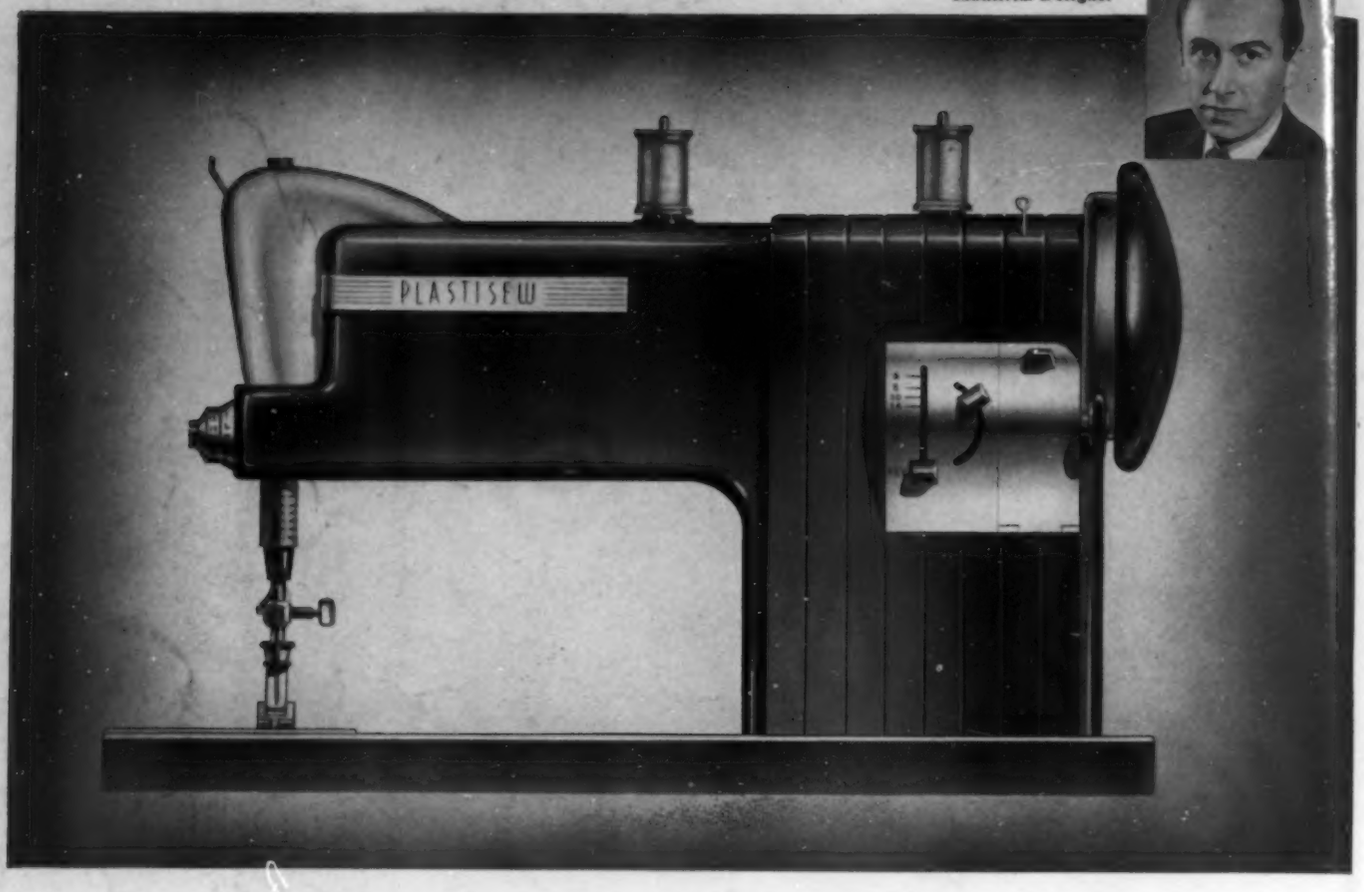
MODERN PLASTICS

AUGUST 1943

★ BUY UNITED STATES WAR BONDS AND STAMPS ★

PETER MÜLLER-MUNK
Industrial Designer



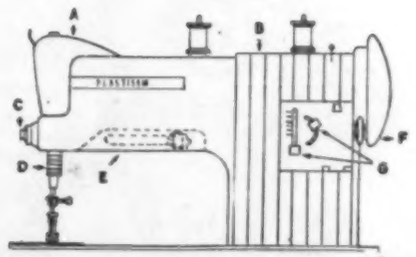
Why are men interested in this sewing machine?

DO YOU ever think about the vast industrial success that has been enjoyed by the manufacturers of sewing machines? What will be the position of their market in the *post*-war era?

Pursuing this thought, Mr. Müller-Munk has re-engineered the sewing machine in the above design for the future . . . incorporating both functional improvements and greater sales-appeal through the use of Durez plastics. As he says . . .

"Even before I ever put pencil to paper, I could visualize what scope Durez plastics would give me in re-designing the conventional machine. First of all, their molding versatility permits the use of complex shapes and sections without adding to production costs. Second, plastics give desirable lightness in weight to the finished product. Third, they have high impact strength, durability, high dielectric resistance. And eye-appeal, of course, in their lustrous finish and handsome colors—a sales advantage exploited in the contrasting-colored housings above."

Here is still another example of how Durez plastics will have a leading position in the re-shaping of America's post-war products. Today, they belong to the men at the war fronts. Tomorrow, they will give physical expression to the way of life we fought for.



FEATURES OF MR. MÜLLER-MUNK'S DESIGN

A End Plate, molded separately of Durez to facilitate assembly

B Molded Durez Motor Housing

C Tension Regulator—shifted to center of End Plate

D Molded Durez Bearing Housing—bearings housed separately to reduce bulk of main molding . . . to provide better visibility

E Light concealed in main molding will always be in correct position for proper illumination of work

F Molded Durez Shaft Disengaging Wheel

G Molded Durez Lever Knobs—redesigned for better grips; better visibility and accuracy in making stitch selection

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DUREZ

PLASTICS THAT FIT THE JOB

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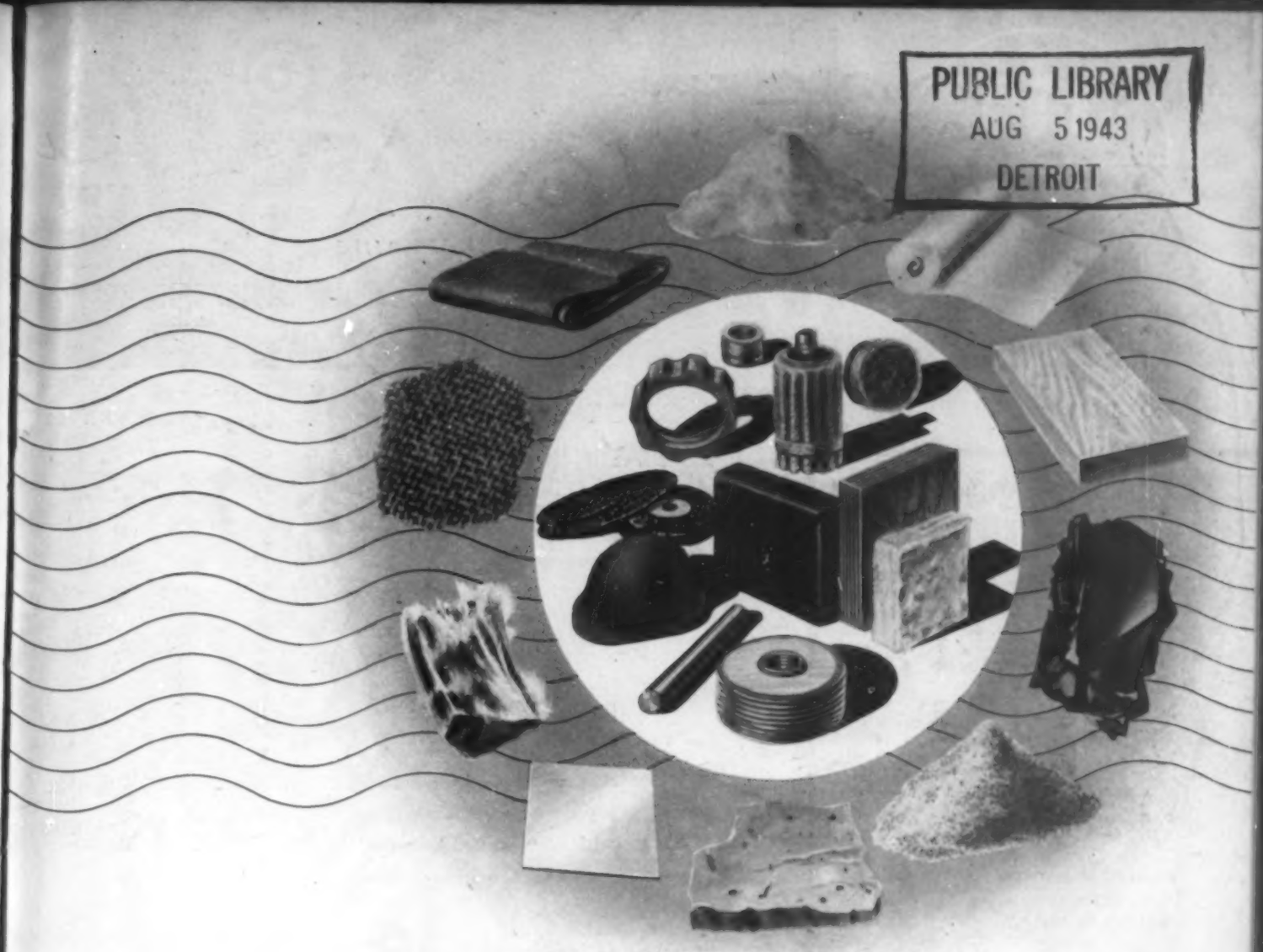

Catalin Liquid Resins

Their industrial importance lies in the good they do—not of themselves—but in combination with other materials!

Add, for example, a specially formulated Catalin liquid resin to cloth—and you have a new material . . . with new properties . . . new potentials. You may only want to waterproof it—or make it fire-retardant—or you may want it to acquire rigidity and strength. Many variations are yours to command!

Technically, the transformations performed by Catalin liquid resins are through the chemical joining processes of heat, or pressure, or their combination; the resins being infused into the treated materials. These steps take the form of impregnating, laminating, bonding, glueing or surface-finishing.

When combined with liquid resins . . . *Paper* becomes durable inner shells of soldiers' helmets . . . *Cloth*, so treated and formed, becomes rigid one-piece pilot seats . . . while *Wood Veneers* formed over mandrels, become shaped parts for gliders and wing assemblies . . . *Cork*, bonded with liquid resin, makes seal-tight gaskets, gun wads and a host of additional useful applications. *Abrasives*, bonded with resins, produce superior grinding discs—they stay cool—cut better—last longer. *Mica*, infused with resins, makes heat-proof table tops, washable wall panels.

And in similar manner, impregnated *Glass Fibres* possess superior insulating qualities. The list is almost endless. It includes the lowly and the lordly—all, through their formulated combinations with Catalin liquid resins, have risen high in industrial importance.

Today, with shortages facing the productive flow of strategic materials, there is even much more that Catalin resins can do in bringing relief—and in establishing new standards of usefulness for postwar development. Our research staff welcomes the opportunity to discuss with you these present and future potentials.

Cast Resins
Molding Compounds
Liquid Resins

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CORPORATION

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m p Plastics

VOLUME 20 AUGUST 1943 NUMBER 12

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Here's where they put SARAN *through the hoops*

SHOWN above is a section of Dow Chemical Company's Saran development department, built, staffed and equipped by the manufacturer of this versatile thermoplastic to perfect new products of Saran and the best ways for plastics fabricators to make them.

Pipe, tubing, rod, cordage, filament—they're all being produced here on National extruders, and in diameters ranging from a few thousandths to half a foot. Some of the products and methods developed in this modern pilot plant you're familiar with . . . others are in the experimental stage, to be released to the industry only when the last of their kinks have been ironed out.

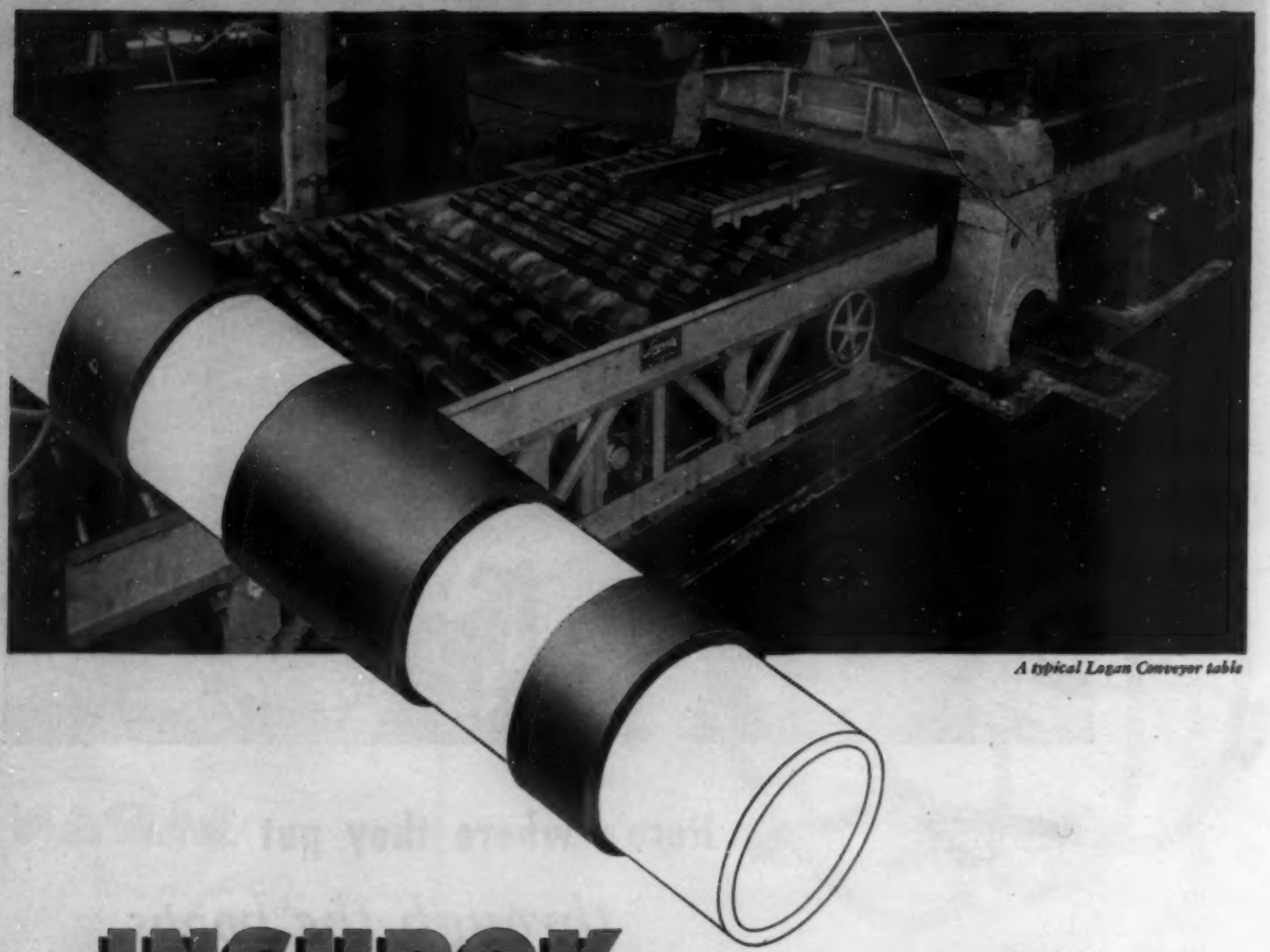
Saran, like other plastic materials, possesses certain characteristics peculiarly its own, and it has been the privilege of National's engineers to work with the Dow organization in developing machines for the fast, accurate and efficient extrusion of Saran in a wide variety of forms.

Playing an important part in all such work is National's own plastics pilot plant. Complete facilities for both research and trial production runs, together with the services of trained engineers, are available here to all who seek to solve problems in plastics.

CLIFTON DIVISION

Plastics Division

NATIONAL RUBBER MACHINERY COMPANY
General Offices: Akron, Ohio



A typical Logan Conveyor table

INSUROK *on the rolls keeps scratches off the sheets*

Stainless steel and aluminum sheets, which are today almost worth their weight in gold, start their trip to fabricators over roller conveyors like this. Protecting the sheets from mars or scratches are sections of INSUROK affixed to the rolls. This is but one of the many ways in which Laminated INSUROK was used to solve problems before the war—is helping to solve them now.

In addition to the many spectacular wartime uses to which INSUROK, molded and laminated, has been put by the armed forces, it is widely used for many commonplace articles—things that you see and use every day. For scores of products for the home, the office, the factory, INSUROK can effect numerous manufacturing economies, can do things which could not heretofore be done, can solve many a postwar problem effectively and economically.

Richardson Plasticians can help you select the grade of Molded or Laminated INSUROK best suited for any mechanical, electrical or chemical applications. They will be glad to suggest the commercial or special grade to meet all the conditions under which your present or postwar product will perform. Write for complete information.

INSUROK

Precision Plastics

The RICHARDSON COMPANY

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FAMED SKY-DRAGON, North American Aviation's B-25 medium bomber ravages Axis installations as her bombardiers sight their targets through enclosure of "Lucite." The B-25 carries a nosepiece, pilot's enclosure and top and tail turrets of "Lucite."

How Du Pont "LUCITE" serves our WINGS OF WAR

"LUCITE" PERFORMS in the top and side panels of this cockpit canopy. Have you guessed the plane? It's North American's pack of pressed dynamite, the P-51 *Mustang* fighter.

THE NOSE-PIECE of Martin's A-30 *Baltimore* bomber, made entirely of "Lucite," is one of the largest plastic pieces ever produced on mass production scale. Famed for its North African service, especially with the 8th Army, the *Baltimore* carries 21 other transparent parts made from "Lucite."

•

"LUCITE" flies to war also with the Douglas *Havoc*, Lockheed *Lightning*, Republic *Thunderbolt*, Curtiss *Warhawk*, Consolidated *Liberator*, Bell *Airacobra* and many more of our foremost war eagles.

CRYSTAL-CLEAR transparent Du Pont "Lucite" methyl methacrylate resin sheeting serves American battleplanes at any altitude, in every climate, all over the world.

Enclosures, as well as other parts made from "Lucite," are light, strong, resilient—dependable in service. Because the sheeting can be formed into wide areas, "Lucite" allows pilots, navigators, gunners and bombardiers maximum vision under all conditions. If damaged by gunfire, "Lucite" sheeting can be repaired simply and effectively.

Here are some of the properties of cast "Lucite" which explain why *America's outstanding acrylic plastic* lends itself so successfully to the needs of military aircraft. Why, too, "Lucite" will prove so important in the building of our post-war world.

Under standard conditions (77° F. 50% R.H.), cast "Lucite" shows...

Tensile Strength—6,000-9,000 psi
Flexural Strength—10,000-14,000 psi
Impact Strength—(Charpy) 0.4-0.6 ft. lbs. per in. of notch;—(Izod) 0.2-0.4 ft. lbs. per in. of notch
Linear Thermal Expansion—(0°-21°C) 7-9 x 10^{-5} per °C
Yield Temperature—(cantilever beam) 80°C
Light Transmission—(visible range, uncorrected for reflection) 90-92%
Dielectric Constant—(10^6 cycles) 2.5-3.0
Specific Gravity—1.18-1.20
Water Absorption—(24 hours' immersion) 0.2-0.3% by weight
Effect of Sunlight—practically none
Effect of Age—practically none

(Many properties are influenced by temperature, stress applied, alignment of molecules in forming and by contour of finished members, which should be compensated for in design.)

• • •

SEE THIS MANUAL FOR MORE DATA

The 114-page Manual on "Lucite," for aircraft designers, engineers, their established enclosure suppliers and for fabricators of plastics, gives detailed information on fabricating, forming, repairing and general properties of "Lucite." Get your *free* copy. Write on your business letterhead to: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., or 5801 So. Broadway, Los Angeles 3, Calif.

DU PONT

REG. U.S. PAT. OFF.

"LUCITE"

methyl methacrylate resin

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

AS a custom molder, our services are for sale to all industries.

Not now, of course. We couldn't handle any new business at any price.

We do expect that we'll be bidding for your contracts sooner than either of us know, however.

And, frankly, we enjoy fighting for orders. It puts us on our mettle not only in production—as our present orders do—but on all fronts: economic, aesthetic, functional.

We don't solicit business on a price basis. We've always tried to serve customers who demand the best molding service we can give, and who expect to pay for it. We're in business to make a profit, and if we can't we'd rather start selling shoelaces.

There are several firms who like us to do their molding. Perhaps, you may be one of them.

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Traveling Light
ON THE THUNDERBOLT

Custom molded, this kick-type ventilator is tough enough for duty on Republic's P-47, America's high-climbing blitz-buster. It is another example of how lightweight Lumarith plastics, packing strength and stamina, are adding extra feet to altitude ceilings. . . . The techniques of the custom molder keep pace with aircraft and industrial design. New, knotty problems involving irregular cores, insert bracings, interchangeability, and dimensional accuracy are solved as they occur. This Lumarith ventilator is typical of the work in plastics which is being done today by the custom molder. . . . If you haven't had experience in securing molded plastic parts, here's how to get what you want: **1.** Specify to us the qualities required in your finished part: impact strength, light transmission, dielectric strength, dimensional stability. . . . We will recommend the plastic for best results. **2.** We put you in touch with the available custom molders best equipped to mold the piece by injection, compression, transfer, or extrusion. **3.** The custom molder will give you a quotation. **4.** We work with the custom molder in selecting the formulation suitable for all factors of production technique in relation to dies, heat, pressure, flow, etc. . . . Success with plastics depends upon the right plastic and the right man at the machine.

CELANESE CELLULOID CORPORATION, ***The First Name in Plastics,*** **a division of Celanese Corporation of America, 180 Madison Avenue, New York City.** ***Representatives:*** **Dayton, Philadelphia, Cleveland, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.**

LUMARITH*

A Celanese Plastic*

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Larger Moldings Now Possible
Plastic moldings, large in area or thickness, now may be uniformly heated with Thermex high frequency equipment. A large form is heated evenly and rapidly, as easily as a small form.
Better, Stronger Finished Products
It is now possible to obtain a plastic product of much greater strength with Thermex high frequency heating equipment. This was revealed today when exhaustive tests indicated this type of uniform heat reduces internal strain and produces a more homogeneous structure.
Less Pressure Saves Molds
Molds and presses last long because much lower pressures can be used, which result in a big saving in replacement of this equipment. Customary pressures often can be reduced as much as 80%.
CURING, PREHEATING & TRANSFER TIME GREATLY REDUCED
Preheating and curing time cycles may be reduced more than 75% with Thermex high frequency equipment. Transfer time is likewise greatly reduced. Thermex provides heat throughout the material at phenomenal speeds.

These and many more advantages are possible with

THERMEX *High Frequency Heating for* PLASTIC MATERIALS

Much larger moldings are practical because Thermex heats preforms uniformly throughout the mass, almost regardless of thickness or area.

Great flexibility in operation is possible. A wide variety of items and sizes can be handled efficiently. One or several presses may be operated from a single Thermex unit.

Thermex high frequency heating produces a higher quality final product because it provides uniform flow of the material throughout the mold. The better flow properties and less internal strain assure a stronger, more homogeneous structure.

For these and many other reasons, you are urged to seriously consider Thermex high frequency heating. Write for further information.

The GIRDLER CORPORATION

Pioneers in Industrial High Frequency Heating

THERMEX DIVISION **LOUISVILLE, KENTUCKY**

Buy another WAR BOND this week!

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If you have a plastics problem...if you need plastic materials...see NIXON. You will get quick action in any case ...and quick delivery if the materials are readily available. Our plant facilities are amply large to take care of any size order and our sales and service organization is set up to give customers quick action on all inquiries, regardless of their size. If you need that sort of action...see NIXON.

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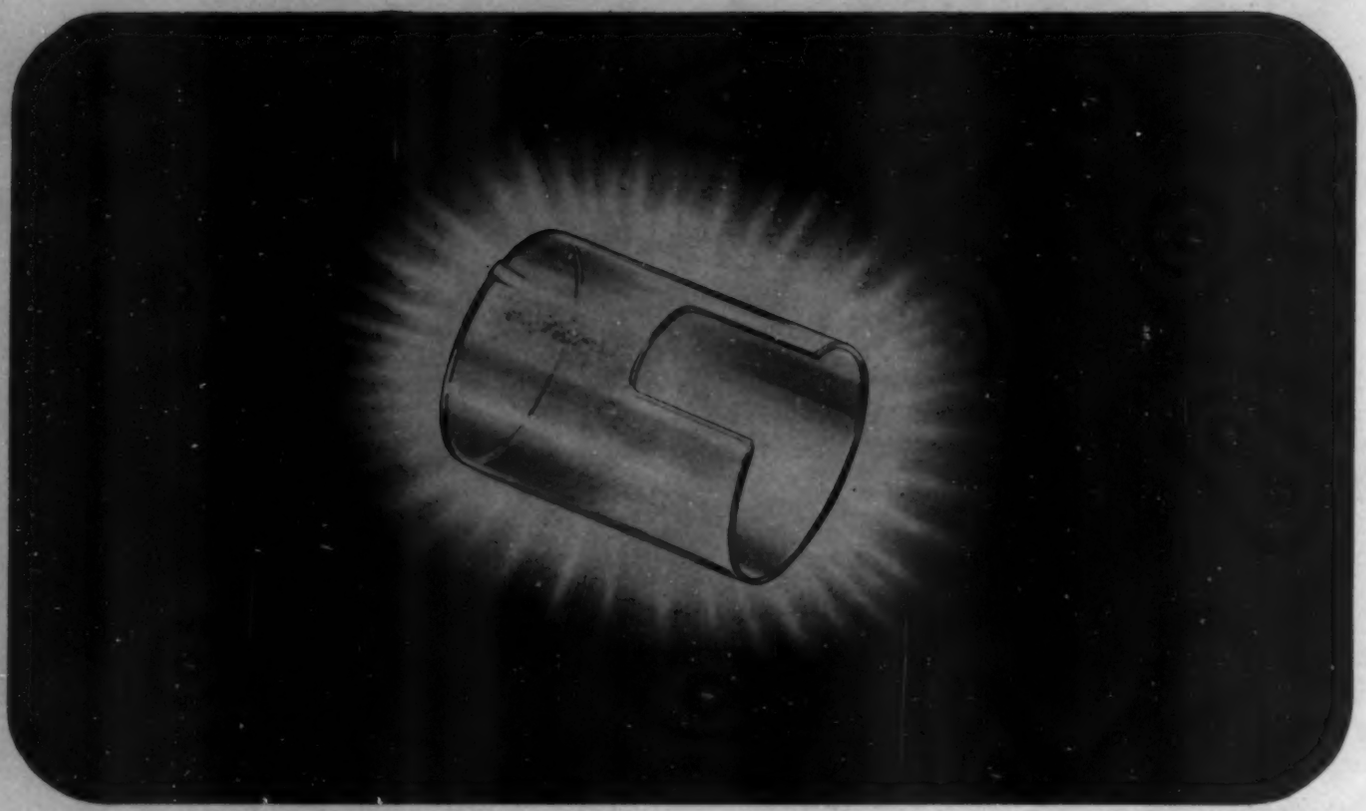
IN MOLDED PLASTICS



This molded plastic valve liner provides a smooth, corrosion resistant surface for its working parts. But a *complete valve* of this material could not withstand the required pressure of 150 pounds.

The malleable iron valve body in which this liner is used can easily stand the pressure — but is neither corrosion-proof nor smooth enough to be used alone.

Put them both together, though, and you've got a valve body equalling in performance the one formerly made of brass. The Sloan Valve Company of Chicago makes their new Victory Valve this way — and accelerated service tests, equivalent to six years of heaviest service, show this design can take it. Result: Saving of 4,000,000 lbs. of critical copper a year!

This is the kind of pioneering — and the type of cooperation with manufacturers' engineers — that's built the nation-wide reputation of CMP development engineers. Behind these men stand the finest production facilities in the middle west. Wouldn't you like to have them look over your problems? No obligation — just call or write.

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This war-born product is an auxiliary fuel tank that adds important miles to American airmen's bombing missions. It is made of Taylor Fibre. Why? Because Taylor Fibre sheets, shipped and stored flat, are quickly and easily formed to make these light-weight, leak-proof, auxiliary gas tanks that are so economical in comparison to the importance of their job that they can be discarded in flight, if necessary, as soon as they're empty. You never know what can be done with Vulcanized or Phenol Fibre until you Take it to Taylor

It happened recently in one of our customers' plants. We were an unidentified witness. The workmen were forming an important war instrument from vulcanized fibre sheets.

Suddenly the men stopped their work, turned their backs on the sheets they were using, and replaced them with a new batch that had just been delivered.

"Why the change?" we asked, innocently. "Oh, this is Taylor Fibre," one of the men replied. "We like to work with Taylor. It forms so easily. You can always depend on it. No 'bugs' in it."

Taylor Fibre's dependability is the result of the VERIFIBRE PROCESS—Taylor's name for quality-control. It means that every inch of Taylor Fibre is checked and verified at every step in its manufacturing process—a process that is completely Taylor-controlled under the roof of the industry's most modern plant. Cotton cellulose, papers, resins, chemicals are all produced or refined by Taylor. The result is a finished product that is quality-controlled.

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NORRISTOWN, PENNSYLVANIA

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★

NO pleasure driving—no bright lights downtown—you'll be home a lot this year, especially in the evenings. Instead of the monotony of extra time at home, lots of farsighted folks are making spare time hours pay dividends. They're investing evening hours in a plastics education—preparing for the future when *more* technical knowledge of plastics will be important to their career in this field.

The unusual Home Study plan of Plastics Institute is specially prepared to give you a practical education in plastics. A series of fully illustrated lessons parade the whole plastics world across your desk—included are 29 samples of plastics—you learn about materials—their applications, properties and limitations—methods of molding, laminating, fabricating and casting—design—testing—all the fundamental information of the complete engineering course. You also receive Plastics Trends, a fast moving publication on the new in Plastics.

Whether you are now in plastics or plan to enter this growing field—it will pay you to get complete information on the Plastics Institute Home Study lesson assignments. Write today for the new Booklet on "Rich Rewards in Plastics".

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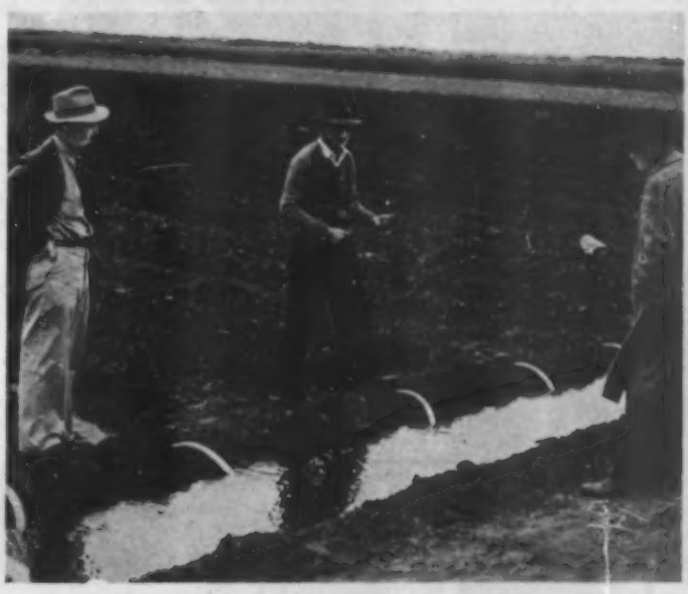
EXTRUDED PLASTICS

Pour it on.



MACOID comes through with another extruding *first*. This time it's for the farmer.

This MACOID development is a one-inch diameter cellulose acetate butyrate tube to help him irrigate his vital crops. This is extruded and then bent to a 120° angle. The pipe is used to siphon water from a lateral ditch to rows of plants. Since its intake end is under water, it does not clog. It saves labor because it is lightweight, easy to carry and set up.

This agricultural development is another in the series of MACOID creations putting extruded plastics to work for new fields. *First* in *automobiles—first* in *furniture—first* in *refrigeration* and *now first* in *agriculture.*

MACOID leads the plastics parade not only by starting first but by staying foremost. We also do injection molding.

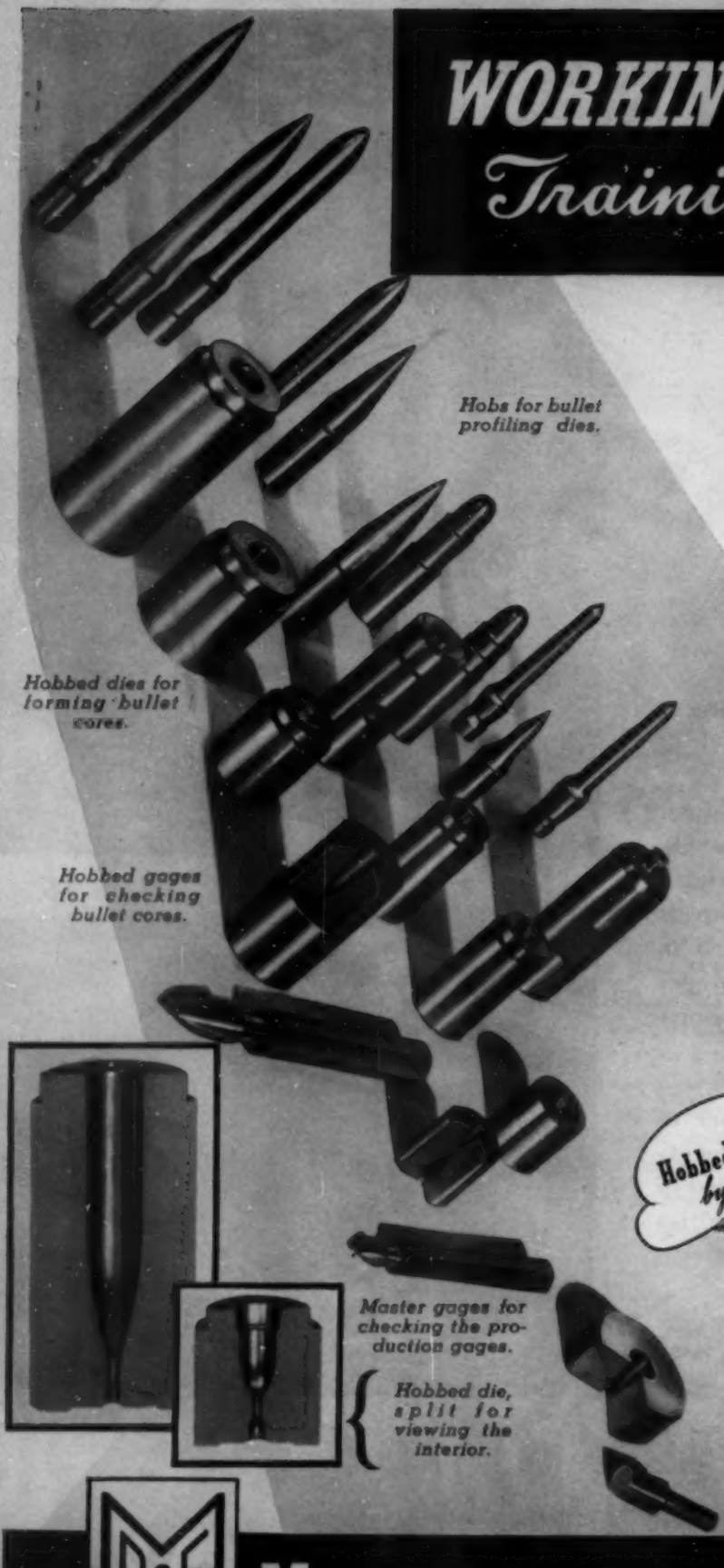
DETROIT MACOID

CORPORATION

12340 Cloverdale Ave. Detroit, Michigan

ORIGINATORS OF DRY PROCESS PLASTIC EXTRUSION

WORKING FOR WAR ...
Training for Peace



Hobs for bullet profiling dies.

Hobbed dies for forming bullet cores.

Hobbed gages for checking bullet cores.

Master gages for checking the production gages.

Hobbed die, split for viewing the interior.

How many millions of bullets must still be made and fired before the Axis yells "enough" is anybody's guess, but we will all agree that the fewer, the better! And because military success depends upon armament superiority, it follows that the "better the fewer!" That has been the guiding principle at Midland, since the first hobbed bullet-profiling dies were made in this plant. Their initial accuracy of .001" was maintained through long runs, by the special hardening process developed at Midland. Hobbed gages to check the bullet cores, and master gages to check the gages, accurate to .0001", complete the Midland contribution to better bullet production.

As long as bullets are needed, let's make bullets that fly true and far; thus the sooner we can stop making them altogether; thus we hasten the day when the skill and equipment necessary to develop such lasting precision in instruments of death can be applied to the accessories of life and progress, after peace is won. *Send your precision mold and die work to Midland.*

Hobbed Cavities by Midland ...

D&E

MIDLAND DIE AND ENGRAVING COMPANY

1800 W. BERENICE AVENUE • • • CHICAGO, ILLINOIS

Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

Harris Armstrong, A.I.A., has studied at Washington University and Ohio State, worked under the late Raymond Hood. From his St. Louis office during the past ten years have come many notable residences and doctors' buildings. For many of these he has also designed furniture.

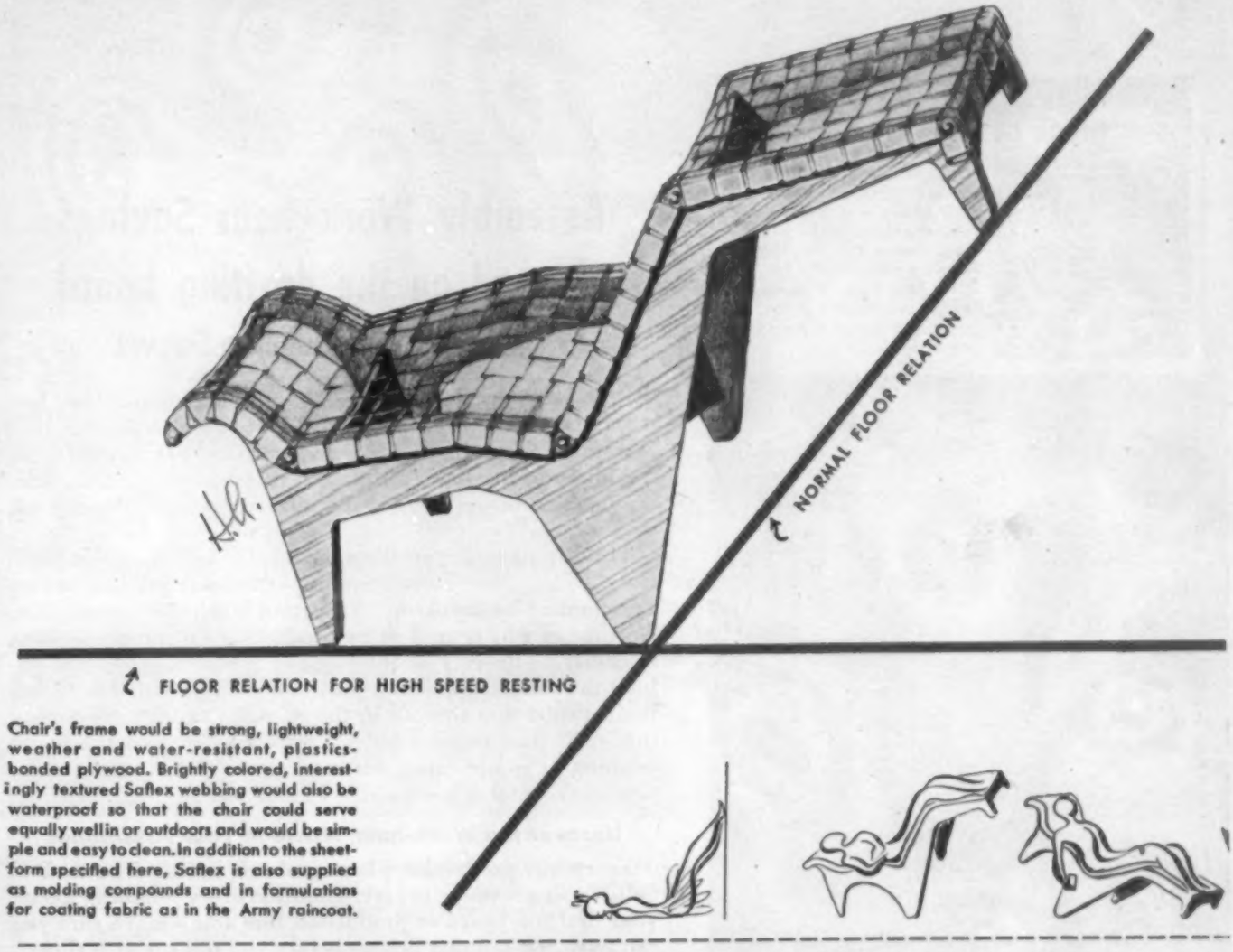
FROM THE ARMY'S NEW RAINCOAT . . . A HIGH SPEED RESTING MACHINE!

ST. LOUIS Architect Harris Armstrong may have had his tongue in his cheek when he named the chair he has sketched below — but he was on sound ground when he designed it to take advantage of a physiological fact long recognized by athletes and ballet dancers: *i.e.*, the human machine relaxes more easily and completely with feet perched higher than the head.

One of the most interesting features of Mr. Armstrong's design is its effective use of Saflex, a material which epitomizes the great versatility of modern plastics and the great strides they have made in answer to wartime needs.

For example, in the Army raincoat Mr. Armstrong is examining in the photograph, Saflex now replaces rubber with marked success, yet the first Saflex compounds were developed to serve as thermoplastic binders for high test safety glass. To fit Saflex for its new job, it was transformed almost overnight from a thermoplastic into a thermosetting material that qualifies as the most rubber-like of all plastics.

In its new formulations, Saflex can be vulcanized and otherwise handled almost exactly like rubber. It can be given a variety of interesting textures and any color, even clear transparent. Particularly it is resilient without actually being elastic—a quality which led Mr. Armstrong to specify webbing woven from board strips of Saflex for his ultra-comfortable chair.



Chair's frame would be strong, lightweight, weather and water-resistant, plastics-bonded plywood. Brightly colored, interestingly textured Saflex webbing would also be waterproof so that the chair could serve equally well in or outdoors and would be simple and easy to clean. In addition to the sheet-form specified here, Saflex is also supplied as molding compounds and in formulations for coating fabric as in the Army raincoat.

The Broad and Versatile Family of Monsanto Plastics

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) • **SAFLEX** (vinyl acetal) • **NITRON** (cellulose nitrate) • **FIBESTOS** (cellulose acetate) • **OPALON** (cast phenolic resin) **RESINOX** (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings • Vuepak Rigid Transparent Packaging Materials

MONSANTO PLASTICS

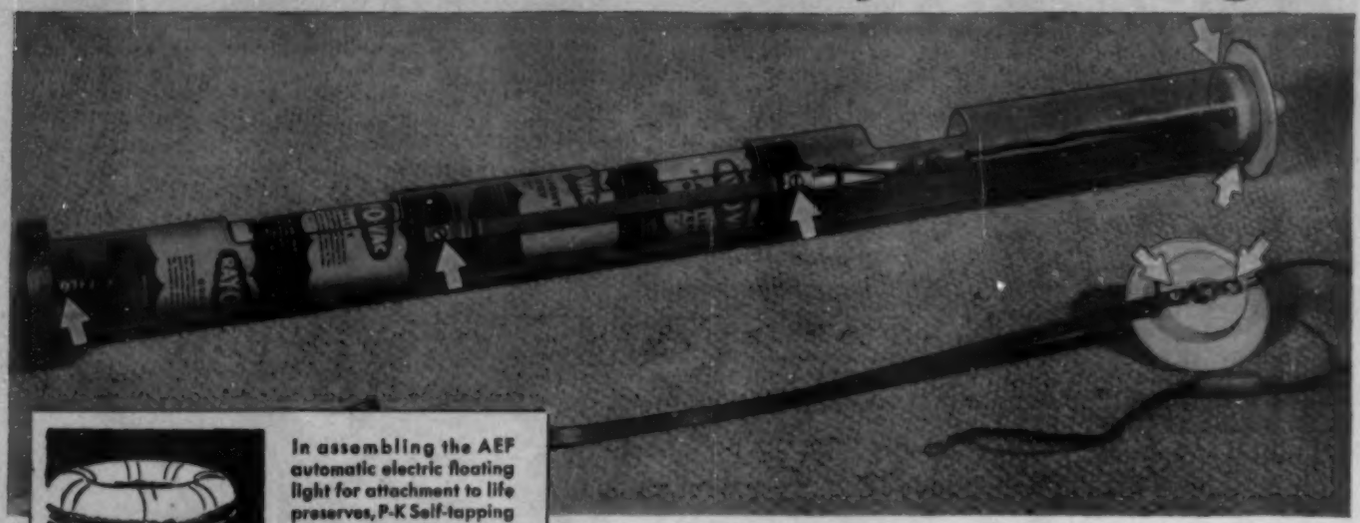
SERVING INDUSTRY...WHICH SERVES MANKIND

FACTS FOR POSTWAR PLANNERS

Saflex and the Resinox or melamine bonding resins which might be used in the plywood frame of Mr. Armstrong's chair are just part of the large Family of Monsanto Plastics, probably the broadest and most versatile group of modern plastics offered by any one manufacturer.

For facts on the entire family—and an overall picture of what plastics are, how they are fabricated and what they promise in the future — see the 24-page guide to Monsanto Plastics recently prepared for product designers. Simply write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

Question every fastening!



In assembling the AEF automatic electric floating light for attachment to life preserves, P-K Self-tapping Screws are used to: Fasten a lug terminal, a brass circuit carrier strip, and the transparent plastic battery container to the Tenite top plate, and to the solid lead base. Also to attach brass strip and the plastic container to fibre circuit spacers.

Assembly Work-hour Savings planned on the drafting board

- with P-K Self-tapping Screws

Able designers planned ahead for production speed and low assembly costs when they specified Parker-Kalon Self-tapping Screws for the AEF Floating Water Light. For ten different fastenings of plastic to plastic and metal to plastic, P-K Self-tapping screws topped every other fastening method for speed, security, and savings.

This ingenious life-saving aid made by A. E. F. Water Light Corporation, New York, is an important war product in record demand by the Army, Navy, and Maritime Commission. No time can be spared in its production for minute-wasting assembly methods. P-K Self-tapping Screws make the assemblies the simplest, quickest way, in one operation. They form their own strong threads in the material as they are turned into drilled or molded holes. Costly tapping and tap maintenance, or complicating inserts, are avoided . . . training of new workers takes less time.

Uncover the Work-hour Waste in Your Assemblies

Every war production plant needs all the work-hours P-K Self-tapping Screws can save. *Question every fastening job* on your drafting board or production line *now* – make sure you can't use Self-tapping Screws before you put up with slower, complicated methods.

Ask for a P-K Assembly Engineer to call and help you uncover all opportunities to gain work-hours, improve products with Self-tapping Screws. Or, mail assembly details for recommendations. Parker-Kalon Corporation, 190-200D Varick Street, New York 14, N. Y.

PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

SELF TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

A NEW LIGHT GOES ON ...all over the world

LIGHTING THE WAY for every branch of our Army, in every quarter of the globe, is this new plastic flashlight with a toughness new in plastics. Within a temperature range of *minus 40°F.* and *plus 180°F.* it meets Army specifications for brittleness and stability. It is tough and it *stays* tough . . . it's made of Ethyl Cellulose.

THIS PLASTIC WITH ENORMOUS post-war promise is now completely devoted to the needs of war. It is a truly amazing material which maintains toughness and stability over the widest temperature range of any thermoplastic. It can be made in *hard* formulations for such uses as canteens, steering wheels, and many aircraft parts . . . *soft* formulations for wire insulation or flexible tubing . . . or used as waterproof and flameproof *coatings* for textiles. It has excellent dielectric properties. Under strictest allocation now, it is importantly worth looking into for the product possibilities of peace.

THE PROPERTIES OF Ethyl Cellulose, which are constantly being developed by Hercules research, are the subject of literature which we think will interest you. You are invited to send for it, addressing Dept. MP-83.

Flashlight by Gits Molding Company from Celanese-Celluloid's "Lumarith E.C." based on Hercules Ethyl Cellulose.

HERCULES

ETHYL CELLULOSE

★

TOUGH · FLEXIBLE · STABLE
LIGHTWEIGHT · ECONOMICAL · CLEAR

HERCULES POWDER COMPANY · WILMINGTON, DELAWARE
Incorporated

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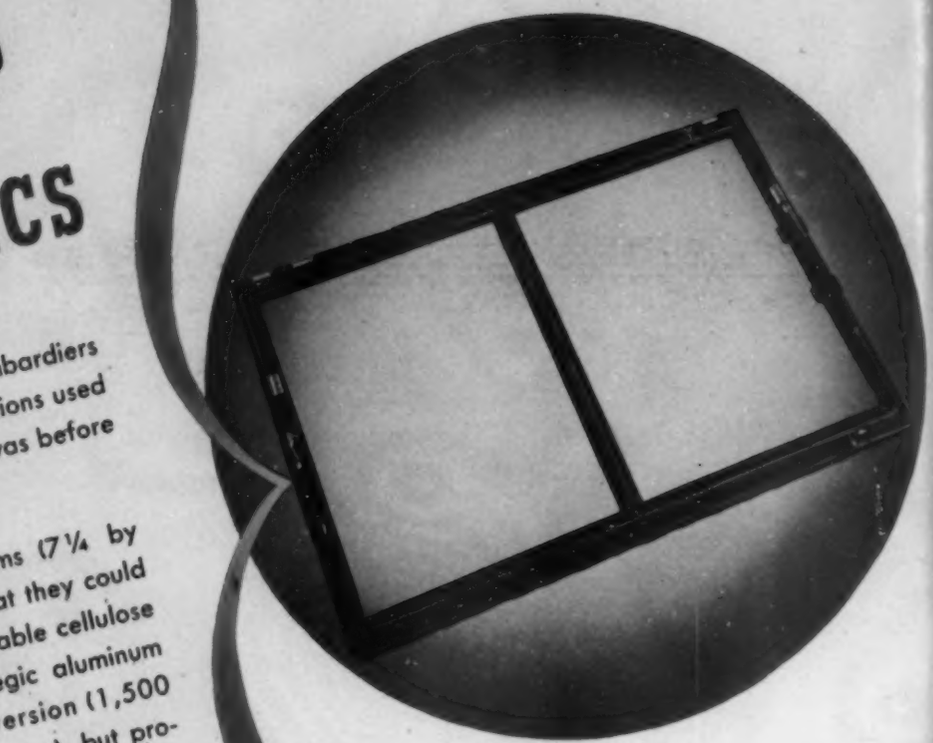
FRAME-UP IN PLASTICS

The recorder frames which bombardiers use to help them check their missions used to be made of aluminum. That was before Cruver began making them.

Although they are large items (7¼ by 12-inches), Cruver proved that they could be injection molded of available cellulose acetate. Not only is strategic aluminum saved by the Cruver conversion (1,500 pounds for each 1,000 frames), but production is speeded as well.

The finished job is considered superior to the metal prototype in all respects — another performance in plastics that points to Cruver as your logical plastics source, now and in peace.



Injection molded cellulose acetate replaces aluminum in Cruver bomb recorder frame conversion.

Cruver

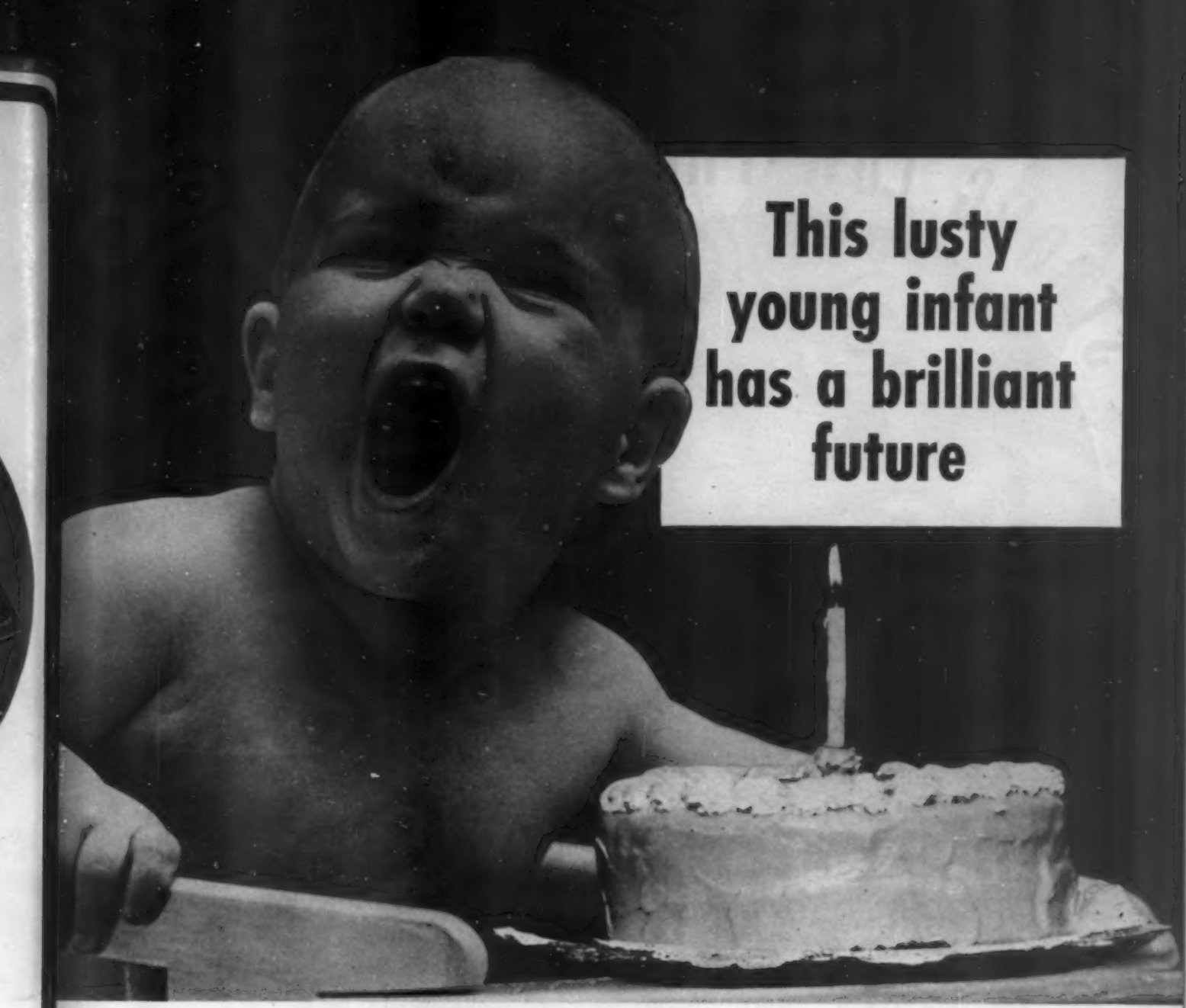
MANUFACTURING COMPANY

NEW YORK
2 West 46th St.
Wisconsin 7-8847

CHICAGO
2456 W. JACKSON BLVD.
Seeley 1300

WASHINGTON
Hotel Washington
Met. 5-900, Ext. 650

SPECIALISTS IN CONVERTING PLASTICS TO WAR



This lusty young infant has a brilliant future

KYS-ITE!

Today, everyone's singing its praises and predicting that it will have a brilliant future in the World of Tomorrow.

Have you a moment? We'll tell you the story.

MEET KYS-ITE. This unusual plastic is made of long pulp fibre and synthetic resin which is preformed to shape before curing. It has all of the inherent characteristics of other plastic materials but can be substituted for metal parts in many industries where strength is paramount.

IT'S STRONG! It has four to five times the impact strength of ordinary plastics — yet weighs but half as much as aluminum! However, for all its lightness, it is resilient and sturdy.

IT'S DURABLE! It will not shatter and it is resistant to chipping in ordinary use. It does not stain. Even boiling it for days fails to disfigure or warp it. It is impervious to mild alkalies and acids.

IT'S VERSATILE! KYS-ITE can be used for trays, typewriters, radios, small machine parts and scores of other things. Because it's non-resonant and non-reverberating, it's ideal for uses where it is desirable to eliminate noise.

IT'S BEAUTIFUL! Lovely KYS-ITE is available in a wide range of rich, sparkling colors. Wiping with a damp cloth retains its brightness.

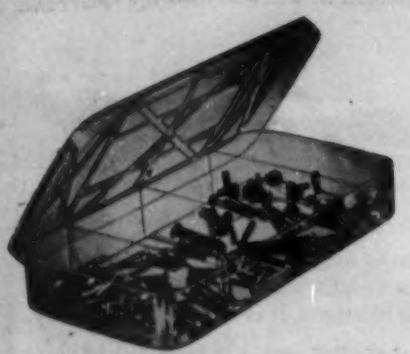
KYS-ITE HAS GONE TO WAR! Certain restrictions now make it unavailable for other than war purposes. Inquiries for post-war applications however will be given intelligent study and careful consideration.

• LET KYS-ITE MOLD YOUR FUTURE •

KEYES FIBRE COMPANY, WATERVILLE, MAINE

STRONG LOW-PRICED TRANSPARENT UTILITY BOXES

STOCK MOLD or CUSTOM MADE



● **We manufacture a complete line of sturdy drawn transparent plastic boxes in all shapes and sizes. Typical models are shown in photo. Every size and shape can be manufactured to meet specifications. Rounds, squares and oblongs are all available, and inserts and partitions may be inserted to meet your requirements.**

These boxes are presently being used by the Army, Navy and Marine Corps for a great many purposes. They are used in war plants for storing and routing sub-assemblies and for small parts in repair and service Departments. They give protection and visibility at the same time.

Production facilities are ample to handle large orders. Prices and samples will be sent on request.

End use of boxes must be permissive under WPB rules and regulations for sample requests and orders to be filled.

THE GREAT AMERICAN PLASTICS CO.

"Plastics Fabricated by Every Method Known to Industry"

INJECTION • EXTRUDING • COMPRESSION • TRANSFER MOLDING • HOLLOW MOLDING & FORMING • SHEETS • ROD-TUBES AND SPECIAL SHAPES

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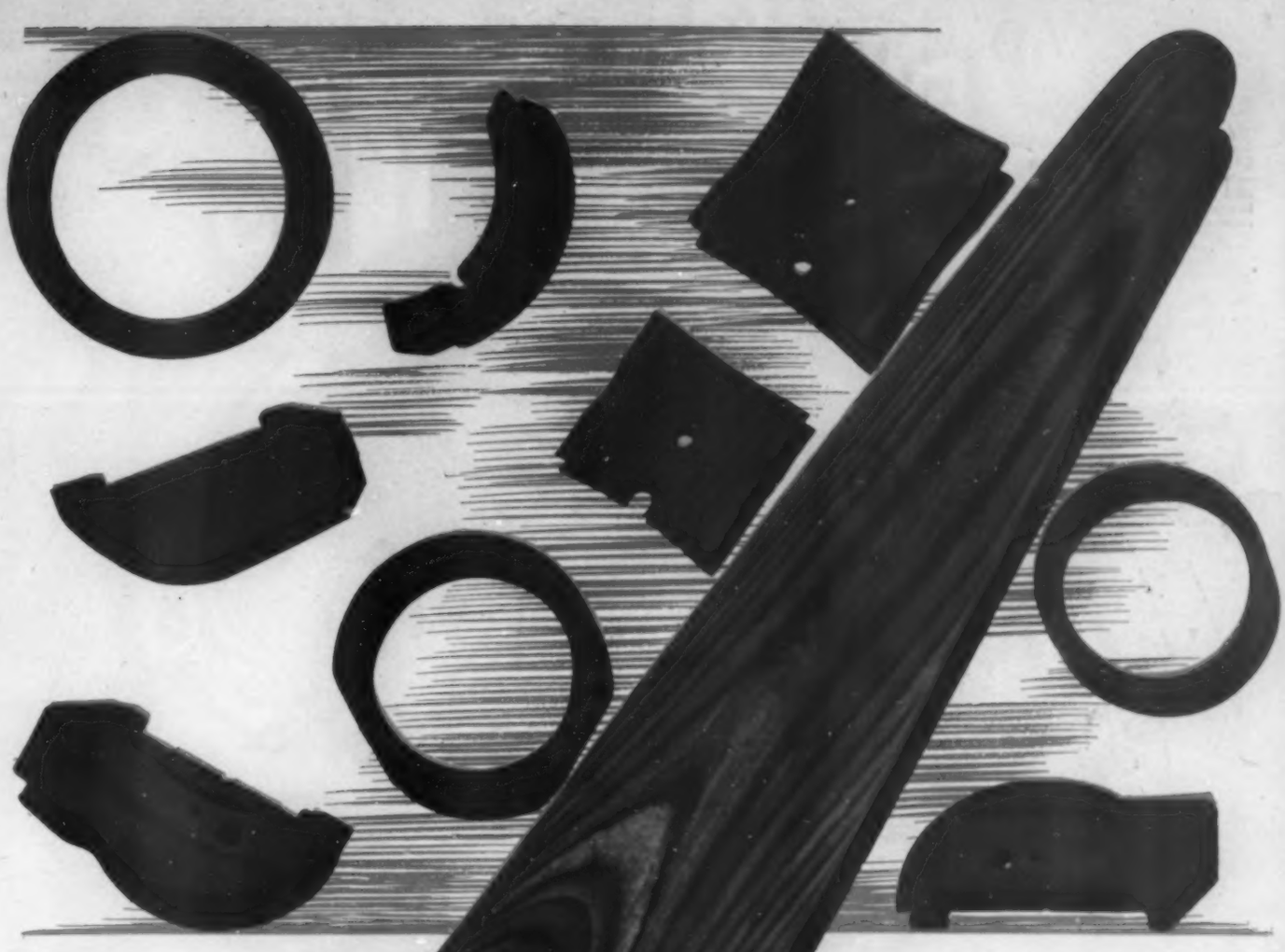
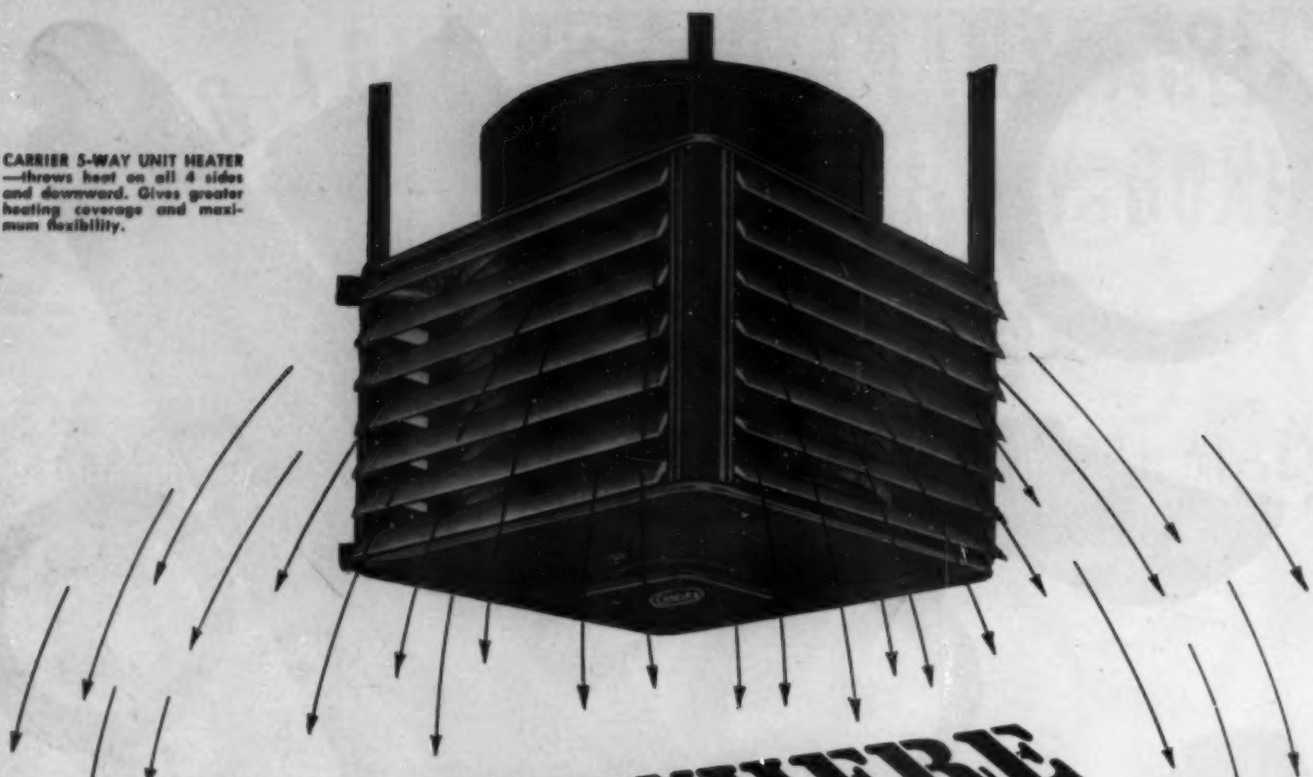


LIGHT • S • STABLE •
PRO LLER PARTS

ALL grades of Formica are light (average specific gravity 1.34) and that makes them adaptable for many uses in airplanes. Some of them are very strong; for instance, the Pregwood used for propeller blades has tensile strength of 30,000 lbs. per square inch; flexural strength 40,000; Modulus, 2,700,000; compressive 15,000 and shear 8,000 pounds per square inch. Canvas base is also used for many propeller parts.

Add to lightness and strength the fact that the material is chemically inert and free from corrosion or deterioration from contact with the atmosphere; that the co-efficient of thermal expansion is very low, as is the moisture absorption—and the value of the material for propeller parts, and air frame parts is easily appreciated. We will furnish more complete data on request.

THE FORMICA INSULATION CO.
4673 Spring Grove Avenue
Cincinnati, Ohio



CARRIER 5-WAY UNIT HEATER —throws heat on all 4 sides and downward. Gives greater heating coverage and maximum flexibility.

HEAT WHERE YOU WANT IT

War plant workers, especially women and older employees, must be kept comfortably warm by adequate heating and ventilating facilities if they are to work at maximum efficiency during winter months.

One of the reasons why absenteeism increases so sharply is the prevalence of colds resulting from lack of proper heating. Cold fingers, too, hinder war production.

Carrier Unit Heaters and Heat Diffusers offer many important advantages in flexibility of arrangement, efficiency and economy of operation, and quick, simple installation. They supply plenty of warm air directly to working areas just where heat is needed. They save fuel and floor space—they save in first cost, installation, operating, and maintenance cost.

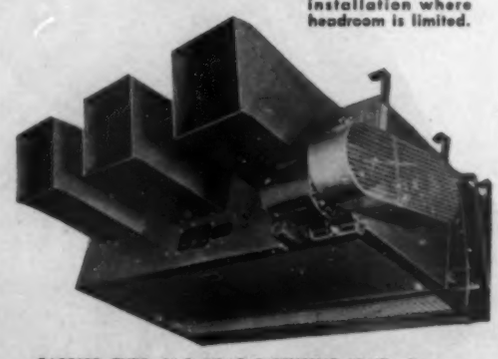
A wide range of propeller and centrifugal fan type units, for steam and hot water, is available for every purpose.

Now is the time to check on the heating needs of your plant for next winter. If departments or machinery have been relocated, changing working areas . . . if old heating equipment is obsolescent . . . if workers were not comfortably warm last winter—you can use Carrier unit heating and heat diffusing equipment to advantage.

Carrier engineers will be glad to make a recommendation regarding type of equipment to best serve your requirements.

CARRIER CORPORATION, Syracuse, N. Y.

CARRIER TYPE 46 E UNIT HEATER — propeller fan; horizontal discharge. Particularly suitable for installation where headroom is limited.



CARRIER TYPE 46 R HEAT DIFFUSING UNIT—for economical heating and ventilating of large enclosures. Designed for horizontal suspension from ceiling or truss-work, floor-mounting, or vertical suspension.

Carrier

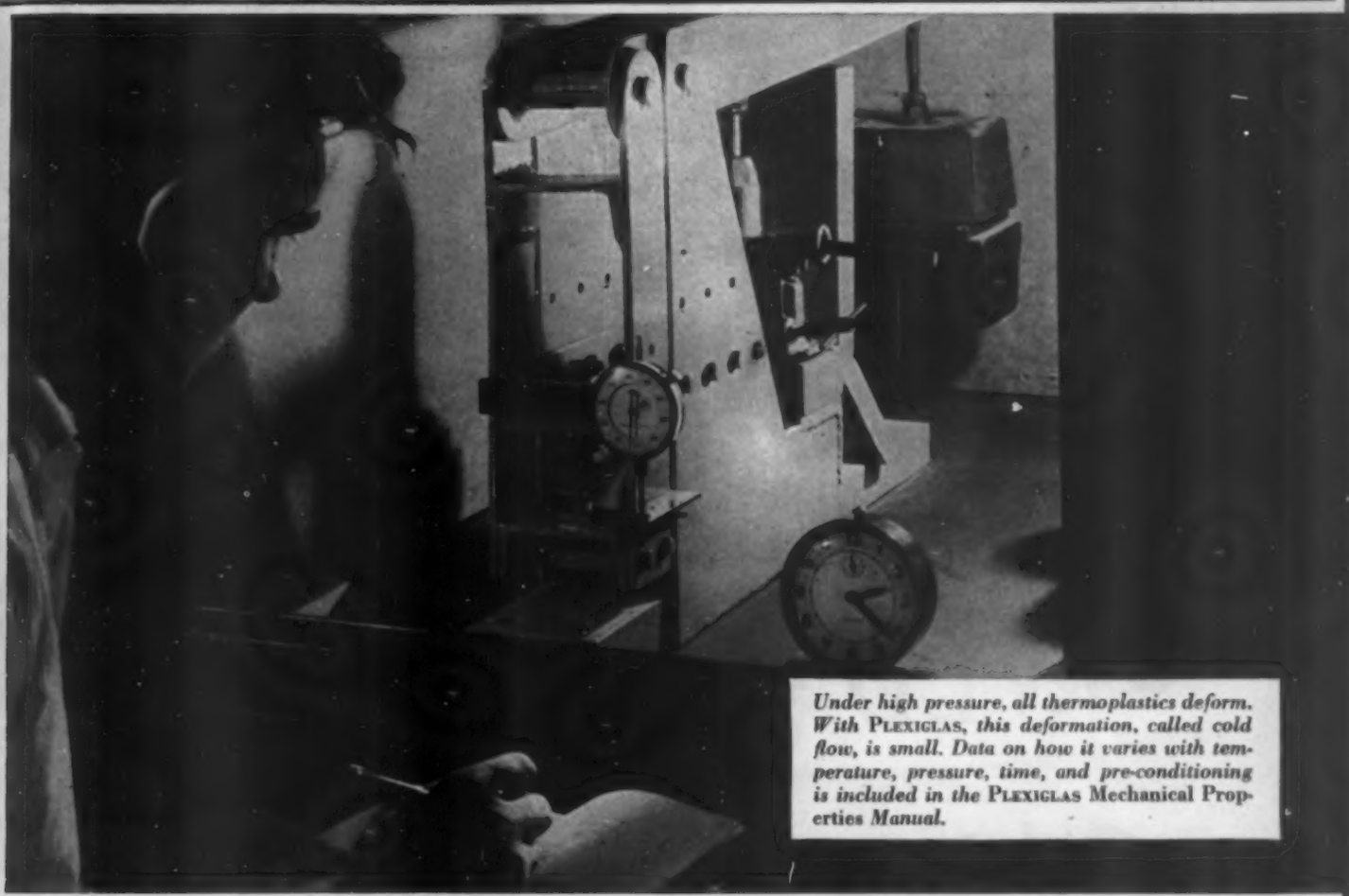
UNIT HEATING

ARMY E NAVY

PUTTING THE PRESSURE ON

Plexiglas

TO GIVE YOU THE DATA YOU NEED



Under high pressure, all thermoplastics deform. With PLEXIGLAS, *this deformation, called cold flow, is small. Data on how it varies with temperature, pressure, time, and pre-conditioning is included in the* PLEXIGLAS Mechanical Properties *Manual.*

IF the design or production of PLEXIGLAS war products is part of your job, let us send you a copy of PLEXIGLAS. *Mechanical Properties.* This new Rohm & Haas publication provides complete information on the important mechanical properties of PLEXIGLAS. Much of the information . . . many of the graphs and photographs it contains . . . have never been previously published.

Write to our Philadelphia office for your copy, today. *Rohm & Haas Company, Washington Square, Philadelphia, Pa.* Other offices in *South Gate, Los Angeles—Detroit—Chicago.* Canadian Distributor—*Hobbs-Glass Ltd., Montreal, Canada.*

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS

SHEETS AND RODS

★

CRYSTALITE

MOLDING POWDER

PLEXIGLAS *and* CRYSTALITE *are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by Rohm & Haas Company.*

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WASHINGTON SQUARE, PHILADELPHIA, PA.

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FIRST in Custom-Machined PLASTICS

SOLVED by BRILHART

TENITE

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BRASS AND POLYSTYRENE MOLDED TOGETHER

Daily the BRILHART Company through its wide experience and engineering skill breaks new bottlenecks on the war production front in PLASTICS.

In addition to creating new high standards of perfection in machining we also do specialized injection molding of small parts and inserts.

Whether your requirements are design ~ production ~ experimental ~ problematical ~ ...if it's plastic... *take it to BRILHART...*

First in Custom-Machined Plastics

ARNOLD BRILHART CO. 435 MIDDLENECK RD. GREAT NECK, N.Y. Phone: GREAT NECK 4054

The Munising Paper Company

GENERAL SALES OFFICES • 135 SOUTH LA SALLE STREET • CHICAGO, ILLINOIS

WATER - A Raw Material of Plastics?

Yes, when paper is used as an impregnating medium. The largest raw material used in paper manufacturing is not wood nor rags - but water. Approximately 400 pounds of water are needed to make one pound of paper. Hence, any objectionable mineral or metallic salt in water exposes the fibers to large quantities of these materials.

Following is the analysis of the water used in the manufacturing of pulp and paper at Munising - a WATER SO PURE that a PENNY CAN BE CLEARLY SEEN AT A DEPTH OF 40 FEET.

	Parts per Million
Sulfate (SO_4)	1.0
Chloride (Cl)	4.0
Nitrate (NO_3)	n.d.
Iron (Fe)	*Tr.
Manganese (Mn)	*Tr.
Sodium (Na)	4.0
Mineral Acidity (As $CaCO_3$)	0.0
pH	7.5

*Trace less than 0.1

The above analysis is uniform throughout the various seasons. Uniform, clear water at Munising materially contributes to the uniformity obtained in our impregnating papers.

A leading plastics laminator recently reduced his rejections caused by minerals in the paper stock, from over 25% to less than 2%, after changing to a MUNISING IMPREGNATING PAPER.

If this type of precision manufacture is of interest, may we suggest you contact us.

THE MUNISING PAPER COMPANY

Pulp and Paper Mills:
Munising, Michigan

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135 South LaSalle St.
Chicago, Illinois

MANUFACTURERS OF PRECISION MADE PAPERS FOR MORE THAN FORTY YEARS

To achieve a uniform and maximum bond between woven fabrics and those materials employed in chemical processing requires a high degree of fabric uniformity. That's why Mt. VERNON Extra fabrics are definitely a first choice wherever woven fabrics are to become an intrinsic part of such finished products. Highly uniform—made from a top quality of cotton and manufactured to rigid standards of tolerance—these tough and sturdy fabrics contribute to the uniform penetration of chemicals. Behind every yard of Mt. VERNON Extra fabrics is fifty years of industrial fabric making experience. For better processing and more uniform quality in finished products, specify Mt. VERNON Extra fabrics.

MT. VERNON WOODBERRY MILLS, INC.

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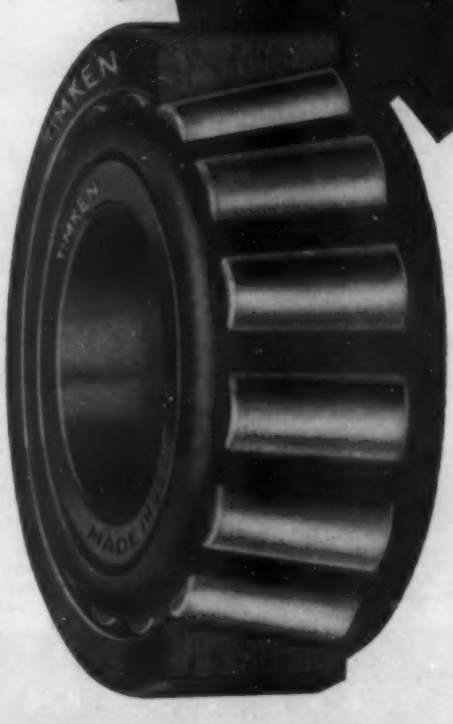
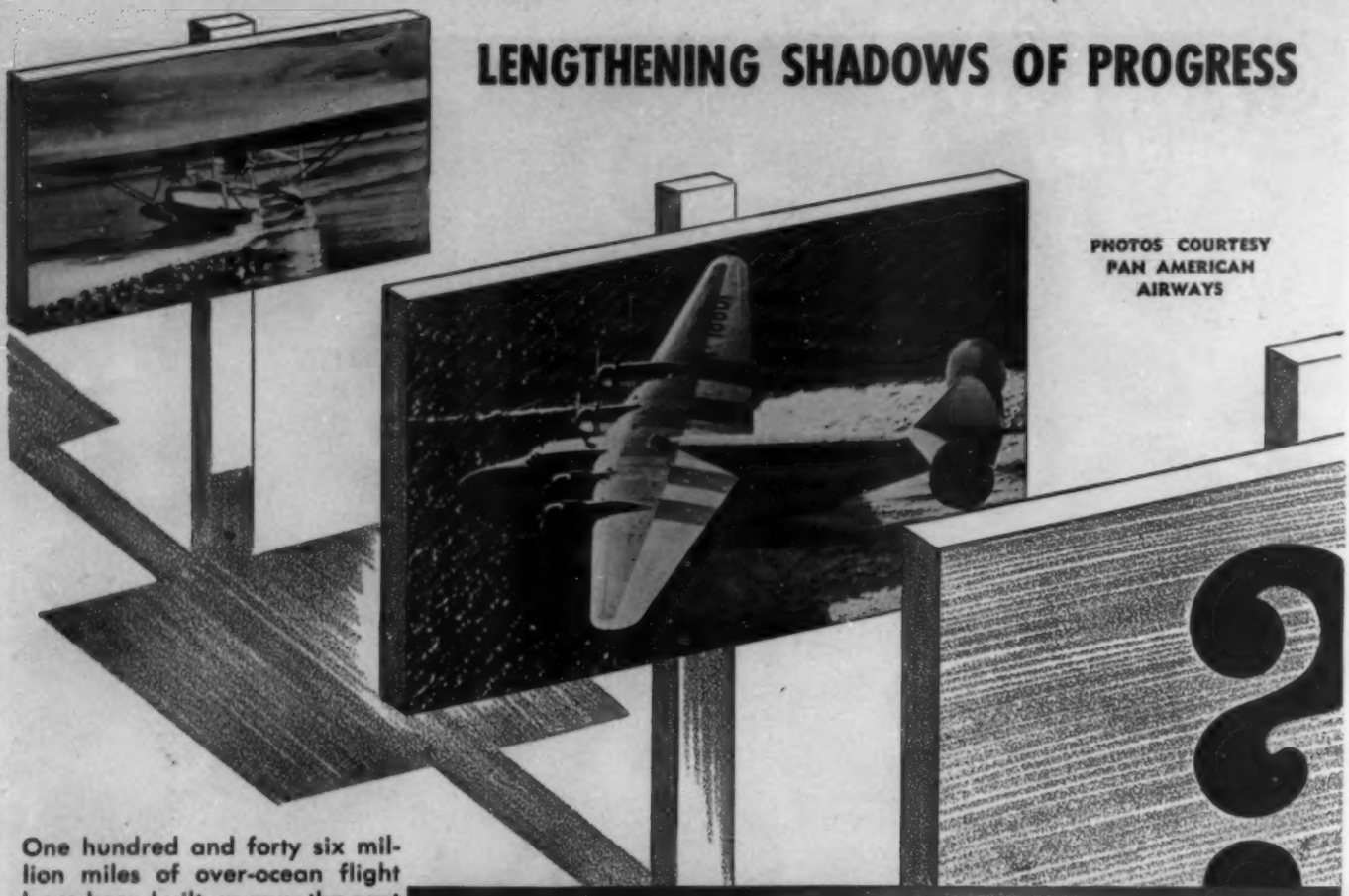


A symbol of quality for any piece of equipment with which it is associated.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

LENGTHENING SHADOWS OF PROGRESS

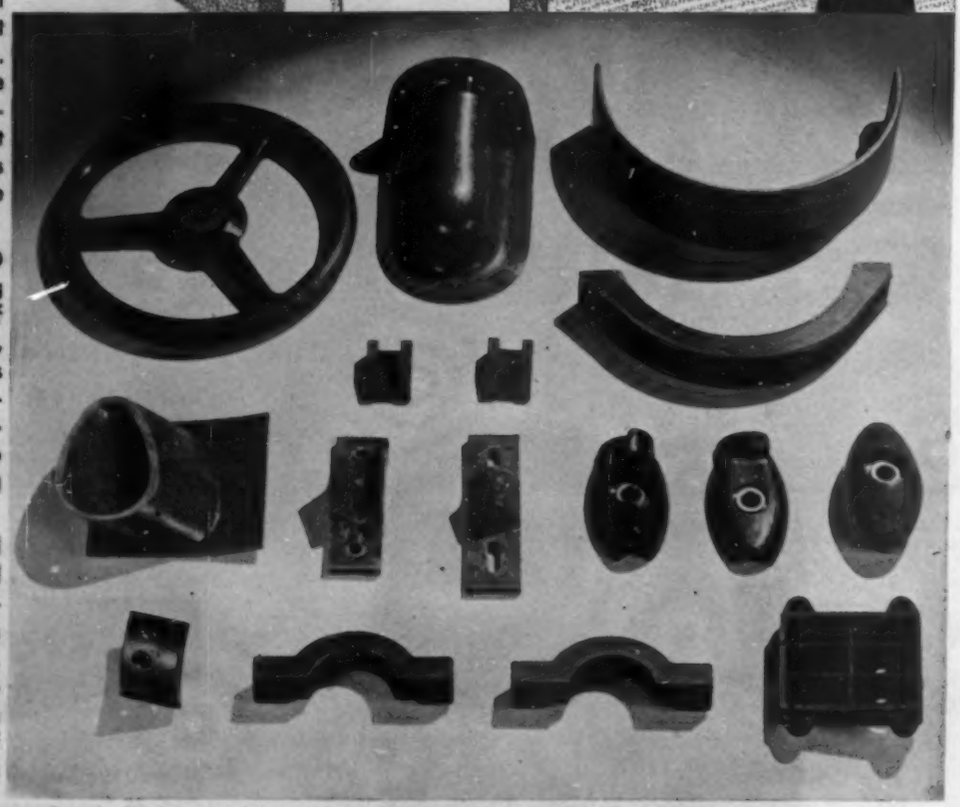


PHOTOS COURTESY PAN AMERICAN AIRWAYS

One hundred and forty six million miles of over-ocean flight have been built up over the past years by Pan American Airways. This enviable record is but the ever-lengthening shadow of progress—a shadow that was first cast in 1927 by Pan American's first marine air transport, the Sikorsky S-30.

In this march of progress C-D plastics likewise are casting ever-lengthening shadows of progress, because of the sound, scientific development on C-D's part that has resulted in producing better-functioning aviation parts that are a great help in making today's huge "flying boats" possible.

C-D Plastics DILECTO laminated phenolics; CELORON molded phenolics; DILECTENE low loss insulation, are all filling vital roles in electrical insulating parts, structural parts and where lightweight, non-corrosive properties and stability under extremes of moisture and temperature are essential.



DISTRICT OFFICES: New York - Cleveland
Chicago - Spartanburg, S. C.
West Coast Rep., Marwood, Ltd., San Francisco
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C-D products include THE PLASTICS . . . DILECTO—a laminated phenolic: CELORON—a molded phenolic: DILECTENE—a pure resin plastic especially suited to U-H-F insulation . . THE NON-METALLICS, DIAMOND Vulcanized Fibre: VULCOID—resin impregnated vulcanized fibre: and MICABOND—built-up mica insulation. Folder GF describes all these products and gives standard sizes and specifications.

Continental - Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

If it's tough send it to problem headquarters

Plastics are saving critical materials, saving money, serving with unheard-of efficiency in thousands of applications. And the huge demand for plastics means a proportionate call for special planning and engineering.

In the midst of war there's not time for puttering by the trial and error method. We crack the tough ones in a hurry because we've had a hand in almost every advance in molding technique. We started molding 67 years ago and grew up with the plastics industry. For decades every new job presented a new problem that had to be figured out and solved. Our engineers work today with a fund of practical knowledge won the hard way—and experience gets quicker results than experiment!

Send the tough ones to us at Auburn. We're problem headquarters. And when we start deliveries you'll find we not only figure them right, but make them right. No Auburn plastics are allowed to gum up an assembly line.

MOLDED PLASTICS DIVISION

AUBURN BUTTON WORKS, INC.

Molders of All Types of Plastic Materials by Compression, Transfer Injection and Extrusion Methods

ESTABLISHED 1876 • AUBURN, N. Y.

A miracle metal... Magnesium serves a vital wartime need in tracer ammunition, parachute flares, and illuminating signals. To reduce this difficult, extremely hazardous metal to powder, Magna Manufacturing Company developed special machinery and precision processes. Now, in three Magna plants... the largest facilities of their kind... we reduce Magnesium to a uniform dust in compliance with rigid U.S. Army and Navy standards.

BUT TOMORROW...

The facilities that Magna perfected open new possibilities for the utilization not only of magnesium but also *all* other types of disintegration-resisting metals and other materials such as ceramics, plastics and pigments.

Magna capacities are today entirely occupied with production for victory. However, Magna engineers are prepared to council forward looking industries on the potentialities of powdered metals and other materials in postwar product planning.

An Invitation...

Manufacturers, design engineers, and technicians are invited to investigate Magna facilities and to work experimentally with our staff to develop new and better products... through the practical disintegration of desirable materials heretofore unavailable in powdered form. Your inquiry is invited.

MAGNA

MANUFACTURING COMPANY, INC.

MANUFACTURERS OF MAGNAFLAKE METAL POWDERS

444 MADISON AVENUE, NEW YORK 22, N. Y.

"The Story Behind the Plant"

A story that relies principally upon pictures to prove its point! An assembly of eight conveniently sized pages that graphically set forth Consolidated's facilities for Compression, Transfer and Injection molding. Scattered, too, through this review are groups of plastic items and parts that indicate engineered planning and manufacturing "know-how". Your request to our home office for a copy of this new "Story" will bring return-mail response.

Consolidated

Molded Products Corporation

"Your Blueprint in Plastic"

309 CHERRY STREET • SCRANTON 2, PA.

NEW YORK	BRIDGEPORT	CLEVELAND	DETROIT	CHICAGO
1790 Broadway	Rocky Ridge Drive	3682 Ingleside Road (Shaker Heights)	2970 West Grand Blvd.	549 West Randolph St.

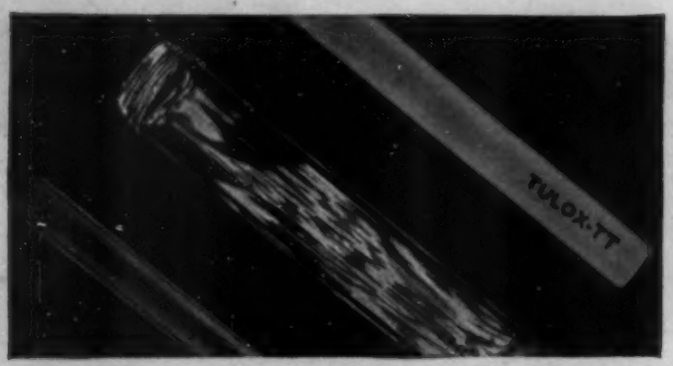
TULOX PLASTIC TUBING

REG. U. S. PAT. OFF.

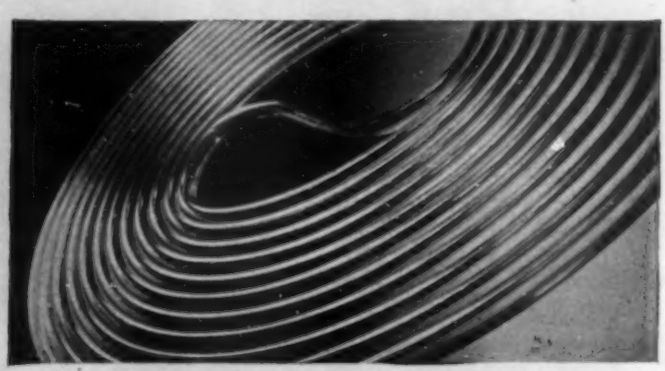
—delivery from warehouse stocks for direct war use only

In hundreds of applications, TULOX saves critical materials. For instance: one pound of TULOX *Seamless* Plastic Tubing (or Hollow Rod) will replace approximately 8 lbs. of copper . . . block tin . . . stainless steel — or 2½ lbs. of aluminum.

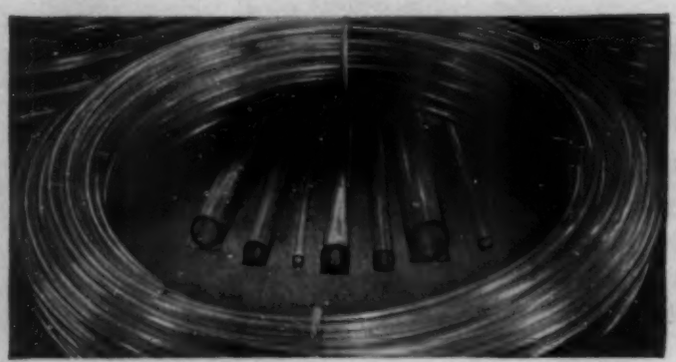
Almost every week, some designer or production man specifies TULOX *Seamless* Plastic Tubing—and releases more critical materials for vital war use. Read below about a few of the many different types of TULOX *Seamless* Plastic Tubing and their uses.



FREE OF STRAIN. Note stress patterns in this illustration. Center section, moulded by conventional process, shows a veritable conflict of strains. Other sections are TULOX Tubing, manufactured by our exclusive process, and show almost no strain.



INTRICATE SHAPES may be formed of TULOX Tubing with application of live steam or hot oil. TULOX Tubing is available in a complete line of *standard* wall and *heavy* wall thicknesses from ⅛" to 2" outside diameter.



TULOX *Seamless* Plastic Tubing is available in a wide range of colors, sizes and types—and in lengths up to 10,000 feet. And *every foot* of it is *uniform* in quality! Accurate dimensions and sharp cross-sections are invariable.

EXPERIMENTS at a mid-western university indicate a tremendous market for TULOX *Seamless* Plastic Tubing on irrigation projects. Freezing and melting of water will not burst this tubing. And . . . TULOX can be flared readily.

FOR REASONS of national security, we are withholding all details of the many interesting applications of our Plastic Tubing, Hollow Rod and Functional Shapes that have been made for the branches of the Federal Government—in connection with war production.

EXTRUDED PLASTICS, Inc.
NEW CANAAN AVE. · NORWALK, CONN.

Manufacturers of TULOX Plastic Tubing . . . TULOX Hollow Rod . . . INTERLOX Functional Shapes

In CANADA: Sole Licensees, DUPLATE CANADA, LTD., PLASTIC DIVISION, OSHAWA, ONTARIO

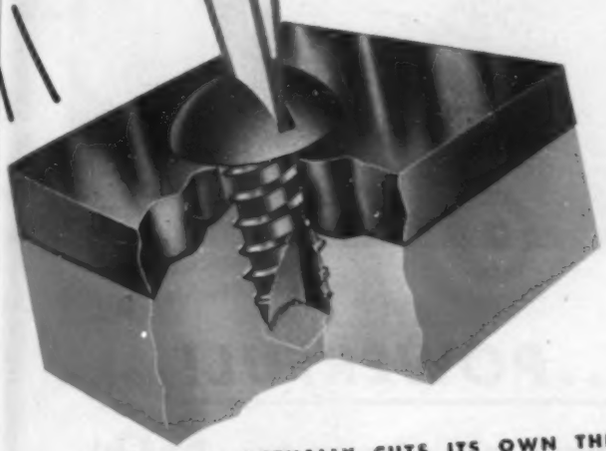
EXPORT DEPT.: AMERICAN STEEL EXPORT CO., INC. 347 Madison Ave., NEW YORK 17, N. Y.

DESIGNED for One Purpose...

End view showing acute 70° cutting edge.

TO FASTEN PLASTIC PARTS

. . . Quickly . . . Safely . . . and Securely!



ACTUALLY CUTS ITS OWN THREAD . . ELIMINATES NEED FOR INSERTS!

SHAKEPROOF TYPE 25 THREAD-CUTTING SCREWS provide many important production advantages. Because each screw cuts its own perfect mating thread as it is driven, the use of threaded inserts or separate tapping is eliminated. Thus, critical parts and materials are saved and molding operations are simplified. Vital minutes are gained in assembly work and a snug-fitting, strong fastening is certain every time.

The wide-spaced thread plus the acute 70° cutting edge assure easy driving with resulting stresses in the material reduced to a minimum. Test this efficient screw yourself—write for handy kit containing samples in various diameters and head styles today!

SHAKEPROOF TYPE 25 THREAD-CUTTING SCREWS

SHAKEPROOF inc.

"fastening Headquarters"

ARMY NAVY

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS

2501 North Keeler Avenue, Chicago, Illinois

Plants at Chicago and Elgin, Illinois • In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

STERLING 1000

New Electric Portable Sander

Tough... Efficient...POWERFUL!

Smooth out operator jitters . . . and smooth out production problems at the same time—with the "Sterling 1000" . . . Power to spare, rapid cutting, yet its scientifically engineered, counterbalanced mechanism operates without trace of vibration! Built like a fine watch, but extra *sturdy* and *tough* for a thousand types of production.

Designed on New Sanding Action Principle!

Orbital, circular, thousands of abrasive grains cut furrows which cross and recross each other. With this action, the "Sterling 1000" cuts faster —produces the smoothest surface on wood, metal, plastic or composition. Ideal for many rubbing and polishing operations.

Write today for your copy of the New "Sterling 1000" folder, describing 21 important features *in detail.*

STERLING TOOL PRODUCTS COMPANY

382 E. OHIO STREET • CHICAGO, ILLINOIS

615 W. Washington Blvd., Los Angeles, Calif. 74 Wellington Street, W., Toronto, Canada

Tops IN PLASTICS

● Plastics has replaced another strategic metal, not only for the duration, but also for the post-war period, because it was found to be more practical and satisfactory. This gable-type cover for the U. S. Army Medical Corps Serological Bath has the advantage over the former copper cover in being transparent as well as resistant to corrosion. The new serological bath equipment is being used by the Army for its Wasserman and Kahn tests with blood samples incubated in constant temperatures of 37° C. and 56° C. Plastics has again proven itself in an important war job . . . and we are proud of this excellent example of our ability to serve you.

Polystyrene gable molded for Precision Scientific Co., Chicago, builders of laboratory equipment.

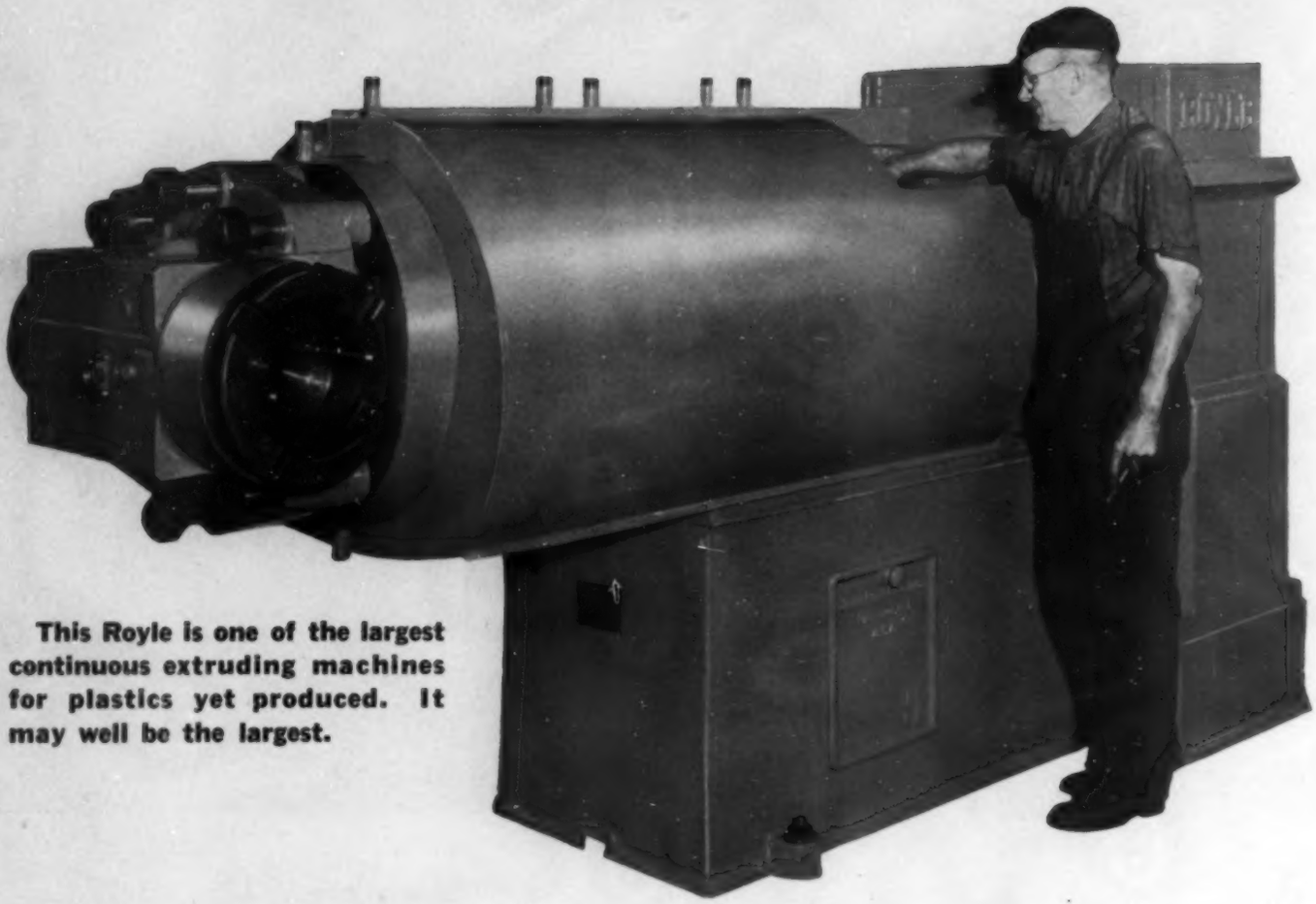
Write on your letterhead for our colorful 40-page catalog containing data and illustrations of Injection Molded and Extruded Plastics . . . if you are interested in ~~MILLS PLASTIC~~ tubing and fittings, write for our new six-page circular.

Elmer E. Mills Corporation

Molders of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Crystallite, Polystyrene, Styron, Lustron, Leslin, Vinylite, Mills-Plastic, Saran and Other Thermoplastic Materials

812 WEST VAN BUREN STREET • CHICAGO, ILLINOIS

Modern as Plastics Themselves



This Royle is one of the largest continuous extruding machines for plastics yet produced. It may well be the largest.

ROYLE MACHINES
for PLASTICS EXTRUSION . . .

. . . . . have set the pace for plastics production equipment ever since the first Royle Extruders were used for cellulose nitrate in 1889.

With each advance in plastics there have come adequate Royle machines to process the new plastic materials. Royal machines are famous for their efficiency and dependability.

Let's Work and Fight for the Free America We Love

JOHN ROYLE & SONS

PATERSON 3, NEW JERSEY

BUILDERS OF A LINE OF GREAT EXTRUDERS FOR RUBBER AND PLASTICS

ROYLE PATERSON N.J.

AKRON, OHIO
Represented by J. C. CLINEFELTER
UNIVERSITY 3726

LONDON, ENG.
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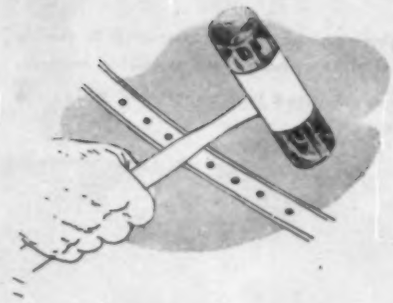
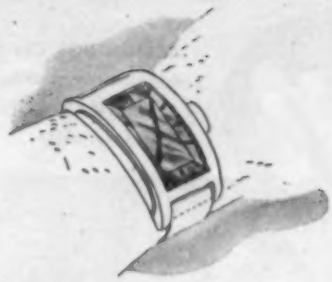
(MACHINERY) LTD.



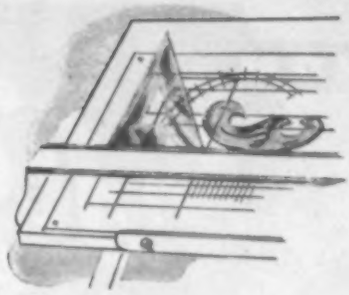
TOUGHNESS

Toughest of all thermoplastics ...makes ideal aluminum-working hammers.



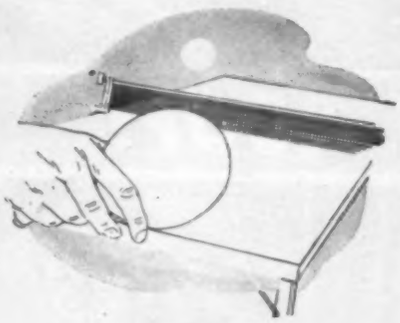
TRANSPARENCY

Crystal-clear transparencies, plus unlimited color effects.



DIMENSIONAL STABILITY

Dimensions remain constant... excellent for rulers, and accurate drawing instruments.

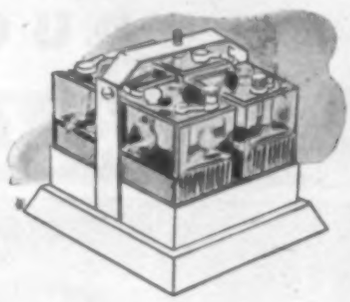


RESILIENCY

Gives ping-pong balls a lively bounce.

EASY FABRICATION

Can be cut, punched, drilled, drawn, printed, molded, cemented.



RESISTANCE TO WATER

Absorbs less than 2 per cent water in 24 hours exposure.

GOOD PROPERTIES APLENTY

Nitrocellulose Plastics

Nitrocellulose plastics offer the clear transparency necessary for making watch crystals, or windshields for motorcycles. They offer toughness and resiliency needed, for example, in hammers for working easily marred metals like aluminum. They have dimensional stability, water resistance, a wide range of colorability. And, to top it all, they lend themselves to speedy fabrication by machining, press forming, extruding, and cementing.

If you are a war manufacturer, you will be interested in finding out more about the potentialities of nitrocellulose for your products. Write to Hercules—largest manufacturer of nitrocellulose for plastics. Address Department MP 13, Wilmington, Delaware.

CELLULOSE PRODUCTS DEPARTMENT

HERCULES POWDER COMPANY

INCORPORATED

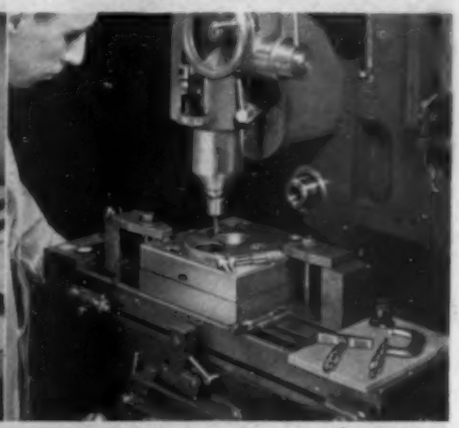
916 MARKET STREET • • WILMINGTON, DELAWARE

FROM *design* TO...

FINISHED PRODUCT

DESIGNING Our plastics engineers will help your own staff to realize fully the remarkable properties of plastics and modern production methods.

MOLD MAKING Our own well-equipped tool department makes the necessary molds . . . and keeps them in repair.



. . . ALL UNDER ONE ROOF!

MOLDING We operate a battery of the finest self-contained hydraulic compression-molding presses in a wide range of sizes.

SPRAYING Where needed, molded parts are sprayed with the latest type of automatic equipment.

FINISHING Modern, semi-automatic equipment puts finishing operations on a real production-line basis.

A completely self-contained organization! You will readily grasp the many advantages to be derived from appointing such an organization as your "molding department."

Responsibility, both for the quality of the product and for prompt delivery, remains undivided. Necessary alterations or repairs in molds can be made without delay. Interplant transportation tie-ups and expense are completely eliminated.

We have the will and the ability to deliver high quality molded parts or products . . . on schedule! Our plant is large enough to provide flexibility and compact enough to permit close supervision. Some of our contracts continue right on "for the duration." Others will terminate within the next few months, creating openings for the production of the compression-molded parts which you require. Send us your specifications for quotations, or have one of our engineers consult with you. MOLDED PRODUCTS COMPANY, 4533 W. Harrison St., Chicago, Ill.

PLASTICS DIVISION

MOLDED PRODUCTS

NORTON LABORATORIES
(INCORPORATED)

CUSTOM MOULDERS OF SYNTHETIC PLASTICS
BAKELITE DUREZ

NORLOC NOVELTIES

LOCKPORT, N.Y.

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, FIRES, ACCIDENTS OR CAUSES BEYOND OUR CONTROL.
CONTRACTS WITH AGENTS NOT VALID UNTIL APPROVED BY AN OFFICER

August, 1943

Gentlemen:

This is our first open letter to you about ourselves.

If we seem a bit formal in our salutation, it's probably because we were just looking at the new smokestack with our name on it.

It makes our plant look a bit more mature, I think, to have our name spelled out in brick. Of course, that isn't why we had the stack built. The real reason is that the place has grown so that we needed a different press arrangement; and that required an additional boiler as insurance for our customers against any delay in filling their orders for moldings.

The smokestack goes with the new boiler room and the new boiler room is part of a more efficient set-up to produce plastics for both now and after the war.

We serve a lot of industries in a fairly wide radius. Perhaps we can serve you, too, sometime. You'll hear from one of us next month.

Sincerely,

J. B. Neal
President

YOU OUGHTA SEE OUR "FAN" MAIL!

Seems like people never tire of telling us how much they admire the way we do our job!

We're mighty jealous of that reputation of ours . . . and we welcome every new opportunity to prove that there just isn't any better plating to be had anywhere than Industrial Hard Chromium.

Because its smooth, twice-as-hard-as-ordinary-steel surface resists abrasion and corrosion, Industrial Hard Chromium Plate conserves precious molds, metals and manhours. Once plated, molds, moving parts, gauges and other equipment may be stripped and replated over and over again, thus continually renewing their useful life.

Whatever your particular plating problem, you can entrust it to the technical knowledge and skill of our engineers and craftsmen. Try us once . . . and we'll be on *your* "fan mail" list for life!

INDUSTRIAL HARD CHROMIUM CO.

"Armorplate for Industry"

15 ROME STREET • NEWARK, NEW JERSEY

Does Your Product

NEED REDESIGNING FOR PLASTICS?

OLD Metal soap dispenser

NEW Plastic soap dispenser

Now is the time to redesign your product *for plastics*—for fast, efficient injection molding—so you'll be prepared to take advantage of the big market opportunities when peace comes . . . Amos is helping many forward-looking companies now—redesigning products that will be ready for *fast production* after the war. The new plastic soap dispenser shown here is a typical Amos redesign job that's in production now for use in the wash rooms of ships, war plants and public places. The improved appearance is obvious, but *better functional use* and fast, *low-cost* production are other advantages . . . Amos can help you now with your *plastic product development* for after the war. Write for 56-page picture-portfolio which tells the story of Amos abilities and facilities.

AMOS MOLDED PLASTICS, EDINBURGH, INDIANA
Division of Amos-Thompson Corporation

Plastic Parts designed and molded by Amos

Amos
MOLDED PLASTICS

Custom Molders of all Thermoplastics by Injection Process

Low Pressure Plastics

ATLAS MOULDED PRODUCTS CO.

Our service of low-pressure Moulding, keyed for speed and precision, is now available to all Industrialists who seek this fast, accurate and inexpensive production.

Mould costs, as compared to high-pressure moulds, are vastly less; delivery is decidedly faster.

If you will submit blueprints and specifications for estimates, our Engineering Department will give your inquiry immediate attention.

Inquiries are especially invited on
BAFFLE PLATES
PITOT TUBE COVERS
TERMINAL BOXES
AMMUNITION BOXES
GUN CHUTE ASSEMBLIES
FAIRINGS — and similar products

ATLAS MOULDED PRODUCTS CO.

33 Franklin Street, BUFFALO 2, N.Y.

MOST VERSATILE War weapon OF THEM ALL!

Actual weapons of war are designed for specific purposes. They can rarely be adapted to other uses. Not so with plastics which have proven such an effective weapon in war production. To overcome two of our most critical bottlenecks . . . shortages of rubber and metals . . . plastics have breached a vital gap in our program and won distinction that time can never dim.

Auto-Lite has frequently demonstrated to manufacturers and engineers the marked superiority of parts and complete articles produced from plastics by injection or compression molding. Perhaps we can show you, too, an important saving in delivery time, actually superior performance along with a substantial reduction in cost through the use of this new medium.

1 Distributor Caps assume many shapes conforming to location and design. Long in mass production by "Bay" from plastics by compression molding.

2 Plastic Grommets for vehicle and aircraft use offer rubber's resiliency plus resistance to hardest service.

3 Aircraft Instrument Cases fitting snugly into the complicated panels of planes are fast replacing metal through their substantial saving in weight and insulating features.

4 Instruction Plates of transparent Vinylite or acetate with decoration on back, can be stamped with serial numbers and other data on front.

5 Phenolic Plastic Panel for parts on aircraft and vehicles. Has clearly defined characters in contrasting colors.

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
BAY CITY MICHIGAN

Specify
AUTO-LITE PLASTICS
FOR THE DURATION . . . AND AFTER

Research

is planning your future

This semi-automatic Compression Molding Machine comes in a complete range of self-contained units with mechanical or hydraulic ejectors. Control by push-button for manual or semi-automatic operation.

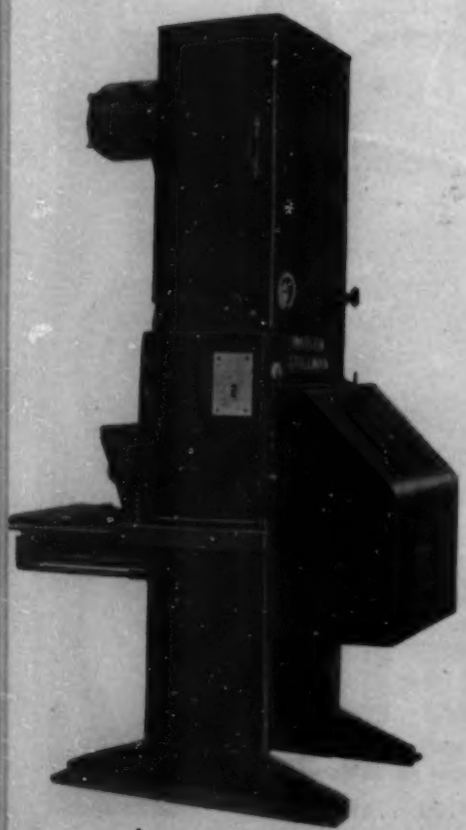
When this war is over, Industry—and particularly that field associated with chemicals and plastics—will face some difficult problems. The change-over to the production of consumer goods, in which plastics have become an important factor, is going to bring great expansion to that business. And the manufacturer who is ready to step into this "game" is going to get the business and make the profit.

In order to serve the Plastics Industry better, Watson-Stillman has enlarged its laboratory facilities. A new building houses complete equipment for conducting RESEARCH into any of the technical problems that will need solving before the Plastics Industry swings into peace-time production. Chemists and Mechanical Engineers are working together in this laboratory. Their combined efforts are directed at finding *better* plastic materials, and designing *better* machines to process them.

Watson-Stillman offers this service to the Plastics Industry as its contribution to post-war "recovery." Bring your problems to us NOW, and let us help you PLAN YOUR FUTURE. The Watson-Stillman Co., Roselle, N. J.

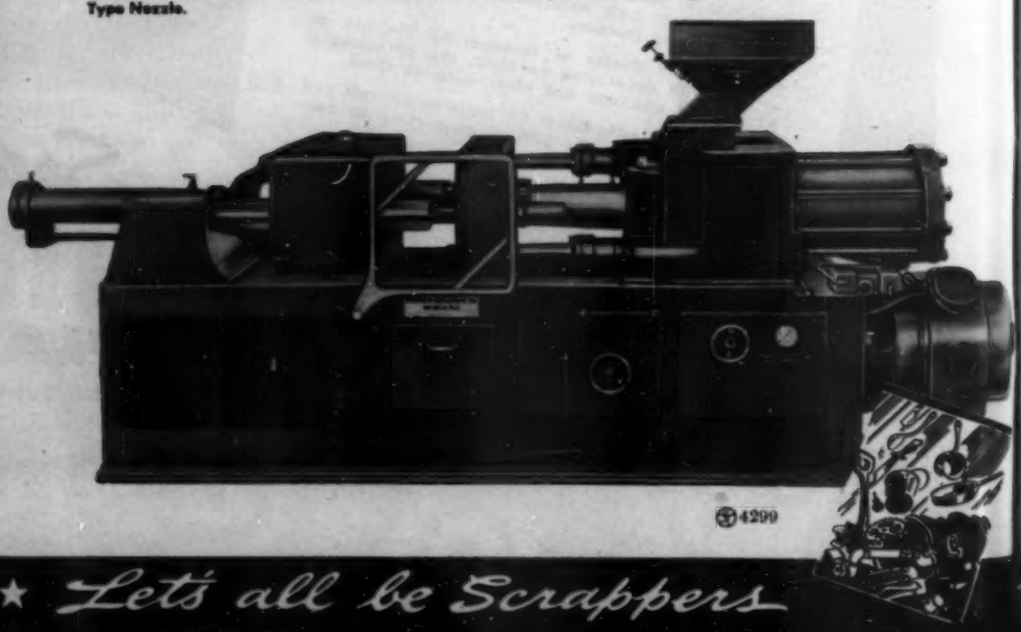
WATSON-STILLMAN

Hydraulic Equipment, Valves, Forged Steel Fittings



The automatic Compression Molding Machine is available in 25-ton, 50-ton and 75-ton types. Has centralized control, positive action, rapid mold changes.

This Injection Molding Machine is available in 6, 8, 12 and 16 oz. capacities. Equipped with Zoning Control Heating Cylinder, Positive Clamping Mechanism, Adapter-Type Nozzle.



4299

For Victory ★★★ Let's all be Scrappers

PULLING TOGETHER

COOPERATION assumes impressive proportions when you put SINKO on the job! Frequently our resourceful engineering staff successfully solves problems that have long defied production by speedy, economical injection molding. Intricate jobs . . inside and outside threads, undercuts, metal reinforced thermoplastics, electrical products and parts requiring infinite precision . . all are taken in stride by pulling together thru the teamwork of our long experienced organization and the many manufacturers they serve. If you are planning now, the products you will depend upon for profits and prestige during the post war years ahead, consider the beauty, color and strength . . the amazing adaptability of SINKO Precision Injection Moldings. Be ready for quick action when the "GO" signal looms ahead! How about pulling together on your problems now?

Sinko

PRECISION INJECTION MOLDING

SINKO TOOL & MANUFACTURING COMPANY, 351 NO. CRAWFORD AVENUE, CHICAGO, ILLINOIS

REPRESENTATIVES: L. D. MOORE, 4030 CHOUTEAU AVE., ST. LOUIS, MO. • POTTER & DUGAN, INC., 29 WILKESON ST., BUFFALO, N.Y. • ARCH MASON, 259 CENTRAL AVE., ROCHESTER, N.Y. H. O. ANDERSON, 202 HERALD BLDG., SYRACUSE, N.Y. • PAUL SEILER, 7779 CORTLAND AVE., DETROIT, MICH. • QUEISSER BROS., 108 EAST NINTH ST., INDIANAPOLIS, IND

Supercar!

(From the Drawing Boards of Sundberg and Ferar)

PLANS for post-war driving call for "supercars" in plastic as suggested by the above conception of outstanding industrial designers.

The combination of light weight, strength and moulding-quality of plastics, plus new moulding techniques, make possible this streamlined, tear-drop body design. Full-vision plastic windows offer new driving safety and pleasure. Plastic accessories and trim add to beauty and to economy of production.

But plastic "supercars" are only one of the many things designers and engineers are thinking of in terms of the future. Planning-ahead in plastics is unrestricted. *In every field* of industrial and consumer application, plastics are being seriously considered for tomorrow. To help you plan your products for the future, call upon the well rounded experience of Kurz-Kasch craftsmen . . . plastic engineers, toolmakers and moulders . . . specialists in plastic design and production for more than a generation.

KURZ-KASCH

Planners and Molders for the Age of Plastics

Kurz-Kasch, Inc., 1417 South Broadway, Dayton, Ohio
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada. *Export Offices:* 89 Broad St., New York City

this Check list of war uses

CAN HELP YOU SAVE TIME-MONEY-METAL WITH

MEYERCORD DECALS

DECALS ARE USED ON:

Airplanes
Tanks
Armored cars
Combat vessels
Cargo ships
Blimps
Gliders
Motorized equipment
Ordnance
Radar
Combat radio communications
Marine — Aircraft
Armor — Portable
Electrical equipment
Navigation devices
Fire control
Bomb racks
First aid kits
Fuel cells (rubber)
Life rafts (rubber)
Helmets
Antennae
Fuel and oil containers
Air filters
Airplane propellers
Fire fighting equipment
Water pumps
Tools
Flares, bombs and shells

DECALS ARE USED FOR:

Insignia (Airplane)
Operation and maintenance instructions
Stowage and packing diagrams
Interior Markings (shipboard)
Instrument panels (also fluorescent)
Nameplates
Wiring diagrams
Fluid line identification charts
Airplane tail numerals
Anti-sabotage inspection seals
Invasion identification (flags)
Windshield passes to vital areas
Spare parts listings
Stowage box identification
Phosphorescent markings (interior)
Organizational devices and insignia
ODT compliance identification
Octane designations
Nomenclature designations
Capacity or load limit
First aid instructions
Assembly coordination numbers
Civilian Defense insignia
Dial faces
Inventory numbers

Identification and instruction data requirements for war equipment are enormous. Uniformity, durability, lasting visibility and speed of application are imperative. In war—*or peace*—Meyercord Decals meet imperative demands . . . on any surface. They're durable, washable, highly visible, permit use of any color and replace strategic metal. No sharp edges, screws, rivets or bolts. This partial list of war-time decal uses may suggest their adaptability to your own product. Competent designing and technical research service available . . . free. Address Dept. 1108.

Speed Victory ▫ ▫ Buy War Bonds!

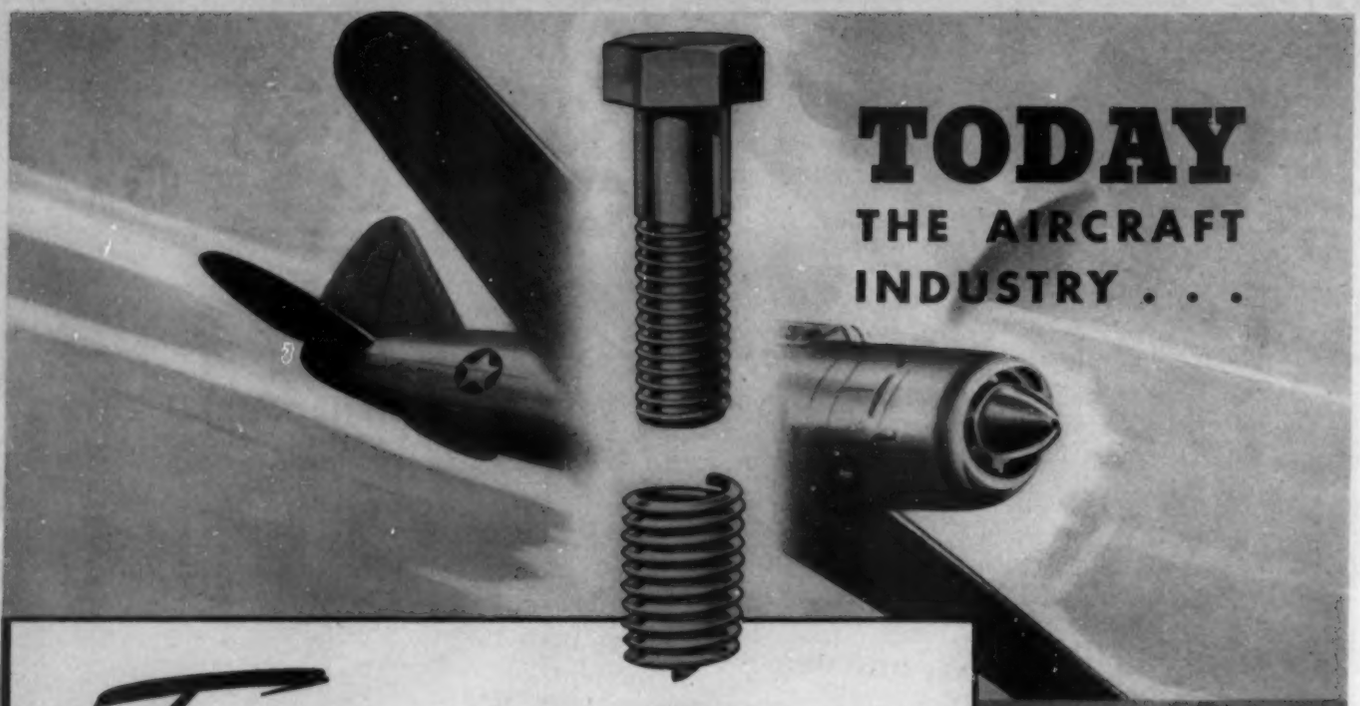
50th Anniversary 1943

DECALS SAVE METAL

THE MEYERCORD CO., CHICAGO

World's largest manufacturer of Decalcomania

5323 WEST LAKE STREET • OFFICES IN PRINCIPAL CITIES



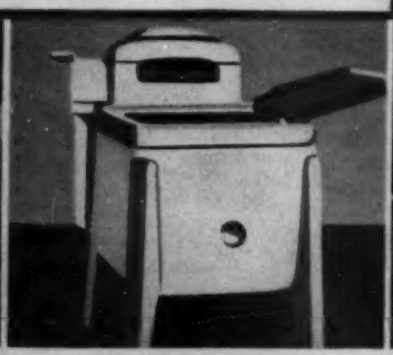
TODAY
THE AIRCRAFT INDUSTRY . . .

Tomorrow ALL INDUSTRY!

Restricted almost entirely to combat aircraft today, the "AERO-THREAD" SYSTEM* for increasing strength and durability of threaded fastenings will have universal use tomorrow. Present trends to lightness—*with strength*—especially in the newer light metals—emphasize the need for this system. Replacing the heavy conventional bushing, it requires a much smaller hole in the boss and permits greater flexibility in design. In plastics it may be molded or tapped in and needs no bonding material.

The "AERO-THREAD" SYSTEM provides a helical coil lining for the tapped thread. Made of precision-shaped stainless steel or phosphor bronze wire of special cross section, it fits a modified Vee tapped thread and a round valley in the screw. It increases fatigue resistance 100%, static strength 25% and greatly reduces chafing and abrasion in the fastening.

Where interchangeability is of primary importance, a variation of the "AERO-THREAD" SYSTEM, known as "HELI-COIL" SCREW THREAD INSERTS, are used. They are applied to threaded fastenings having the American National Thread.



Send for literature containing complete engineering information.

*U. S. and Foreign Patents Issued and Pending.

AERO-THREAD

AIRCRAFT SCREW PRODUCTS COMPANY, INC.

47-23 35th STREET • LONG ISLAND CITY, N. Y.

★ *Number 2 in a Series of Educational Advertisements on Transfer Molding*

LONG CORES

One of the important problems in molding plastics is to achieve, in the molding process, long unsupported cores or holes in the finished piece. TRANSFER MOLDING allows cores in exceedingly narrow diameters and long lengths to be manufactured integrally in thermosetting plastic moldings. These cores are dimensionally accurate. Expensive, time-consuming drilling operations are eliminated.

This is another of the unique features of TRANSFER MOLDING which makes this process the one selected to do jobs other methods cannot accomplish. TRANSFER MOLDING is defined as "the injection molding of heat-hardening plastics."

TRANSFER MOLDING

is the best way to—

1. Handle inserts—metal, glass, ceramic
2. Mold high-impact materials
3. Mold unsupported cores
4. Achieve maximum dimensional accuracy
5. Reduce trapped gases
6. Lower mold costs
7. Lengthen mold life
8. Increase molding speed
9. Reduce finishing costs
10. Improve uniformity of cure regardless of cross-section
11. Save material by eliminating flash
12. Get practical solution to difficult molding problems

—on thermosetting plastics.

SHAW INSULATOR COMPANY

Irvington, SHAW New Jersey

GENERAL INDUSTRIES *Molded Plastics*

● General Industries is making a wide range of molded plastics parts that serve in a diversity of fields in the war and in activities that directly support the fighting fronts. In producing these, General Industries has built on and extended the experience and skill gained throughout the years producing for industrial needs.

By the same token, when the transfer is made back to producing for peacetime needs, General Industries will be better equipped than ever before to render dependable, satisfactory service to manufacturers of industrial equipment, autos, radios, electronic devices, and all manner of appliances that will make the world a better place to live in.

THE GENERAL INDUSTRIES CO.

Molded Plastics Division • Elyria, Ohio

CHICAGO: Phone Central 8431 — NEW YORK: Phone Longacre 5-4107
DETROIT: Phone Madison 2146 — MILWAUKEE: Phone Daly 4057
PHILADELPHIA: Phone Camden 2213

Exploding old assembly methods..

with the Speed Nut System

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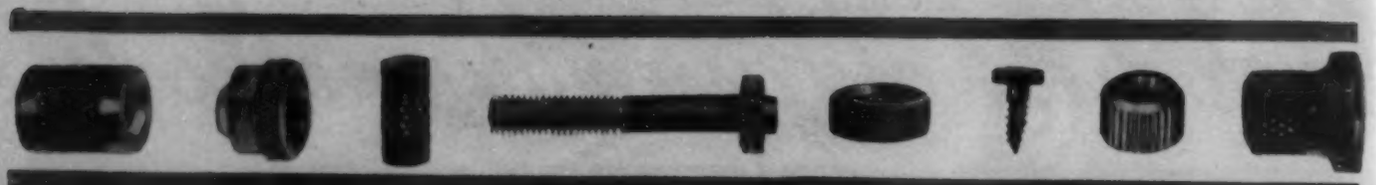

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MODERN PLASTICS
AUGUST 1943 VOLUME 20 NUMBER 12

Low-pressure molding of laminates

Recent developments in molding-laminating which again extend uses for plastics

by F. P. WILSON* and N. D. HANSON†

TIME, temperature and pressure are the variable factors in all plastic laminating and molding processes. One of the first commercially practical and successful applications of thermosetting plastics was in the manufacture of laminated structures, built up with layers of resin-impregnated paper or fabric. These products were produced as flat sheets, tubes or rods. High pressures and temperatures were necessary. Later, molded-laminated shapes of simple design were produced, but high temperatures and pressures were still required. To the plastics research engineer it is obvious that any reduction in the amount of pressure, degree of temperature or time of curing will not only effect economies but will broaden greatly the fields of application for plastics.

This has already been accomplished to a remarkable degree in the production of molded plastics through such processes as transfer, jet molding and heatronic molding. After several years of intensive research, it is now possible to mold laminated structures at low pressures and at reduced temperatures with a consequent reduction in molding time. Today, the time interval of producing laminated products may be a few seconds or many minutes. The pressure applied may be the simple contact pressure of 1/4 lb. per sq. in. effected by a small weight, or it may be the transmitted force of high-pressure hydraulic pumps. The temperature, too, may vary between 70° F. to 500° F.

Low-pressure laminating-molding is a means of distributing a relatively uniform low pressure over a prearranged, resin-bearing, fibrous assembly of cellulose, glass or asbestos, with or without the application of heat from some external source to form a cohered laminated structure possessing definite physical properties. Thus, the low-pressure molding of laminates supplements high-pressure molding and, therefore, enlarges the field of application for high-strength molded-laminated plastics.

The availability of pressing equipment and molds, the time and capital allotted to produce finished molded products, the total number of parts to be produced in a given period and the ever-present uncertainty of standardized designs and dimensions in some industries are factors which should greatly influence the applications of the low-pressure molding process. The types of molds and pressure actuating systems for this process are numerous. The following general systems are already in use:

1. Hat press type—cast aluminum male or female mold sections with a rubber bag; hydraulic pressure; also cast metal force and metal chase with a rubber bag (flat bag).

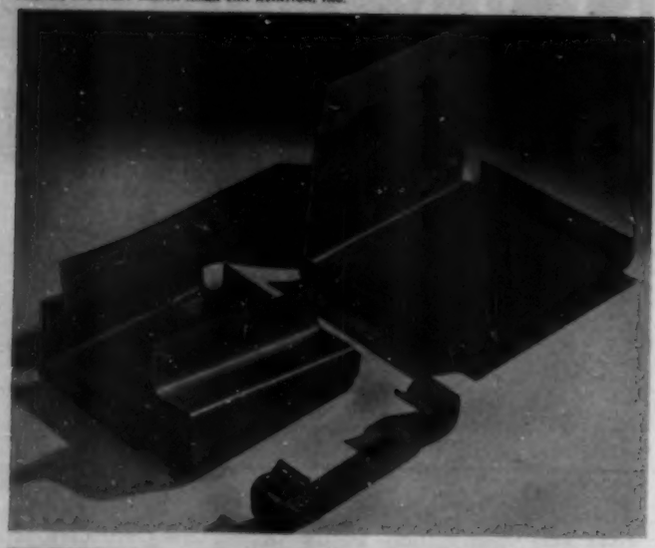
* Technical engineer, Bakelite Corp.
† Development Laboratories, Bakelite Corp.

1—This gun turret seat, here viewed from the top, is molded of high-strength phenolic paper laminate with a thickness of one-tenth inch. **2**—*The complete air-conditioning unit, center, is finished with aluminum paint. The single section at right is in natural color while that at the left has received a primary coat*

1 PHOTO, COURTESY MCDONNELL AIRCRAFT CORP.

2 PHOTO, COURTESY HAT CORP. OF AMERICA

PHOTOS, COURTESY NORTH AMERICAN AVIATION, INC.



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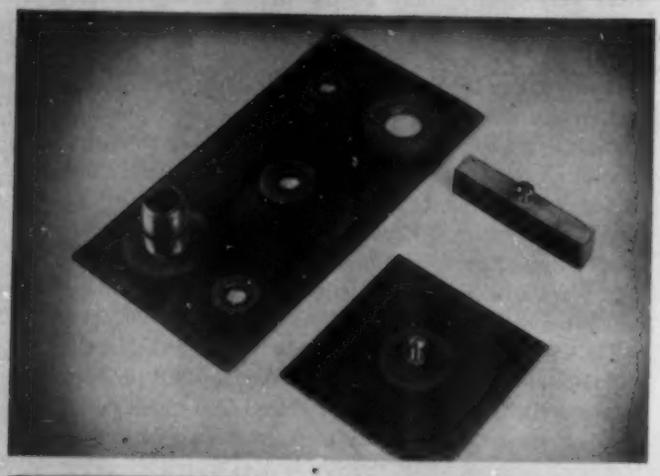

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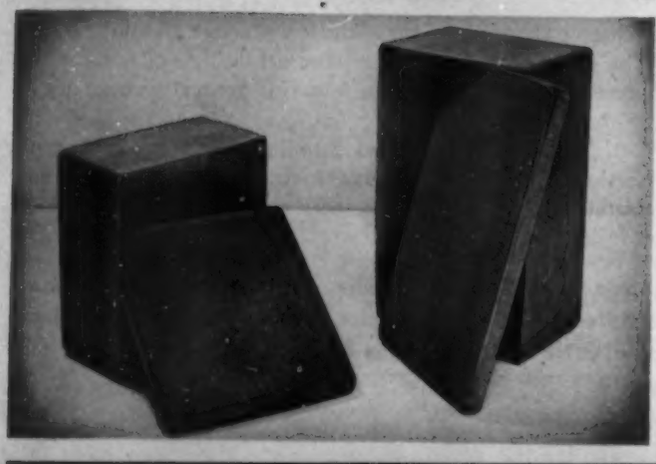

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2. Hat press modification—cast or welded female molds, steam jacketed; rubber bag inserted in cavity; air or hydraulic inflation.

3. Combinations of cement and wood, plaster of Paris and wood, plastic of Paris and metal, metal-faced wood; cast metal chase, and cast metal force plugs.

4. Autoclave method—wood, cement, metal, etc., forms, with a rubber bag; reduced pressure in bag and air, or steam pressure in autoclave.

5. Rubber blanket process—metal mold with rubber blanket on one side, assembled between platens of hydraulic press.

In actual production it has been found advantageous to insert a sheet of regenerated cellulose film between the resin-fiber assembly and the rubber bag, or between the charge and the cement, wood, plaster or metal surface. This operation prevents any adhesion occurring from a direct contact with mold surfaces.

As for the resins employed, there are at present three general types used for specific applications. These types with their subclassifications are shown in Table I.

Many of the cold- and warm-hardening resins were developed for the plywood industry. Variations in the formulations of the "hardeners" produce different hardening and plasticity characteristics at various temperatures and varying pressures.

The thermosetting ester types, some of which were laboratory curiosities a few years ago, have found a place of usefulness in very low-pressure molding applications. This type of liquid resin, because of the absence of solvents, may be processed without drying the coated fabric. The assembly of wet sheets is placed in the mold or a continuous web of the coated material may be wound on forms or mandrels. It may be necessary to add thickening agents to the liquid resins to prevent migration or flow of the fluid resin during the initial molding or baking cycles. Dimensional stability of thermo-

3—These thermoelastic formed parts are of standard C grade, Type II thermosetting laminated fabric base sheet. 4—The holes in this resin-impregnated low-pressure laminated P-18 cloth with its metal inserts, are drilled and tapped after molding. The small piece, right, was drilled and tapped cross grain without splitting. 5—Junction boxes molded (right to left) of 5- and 6-ply impregnated duck. 6—Holes for the hinge pin are molded as integral parts of these resin-impregnated P-18 cloth low-pressure laminated hinges. 7—Small box of flat-hinged sections

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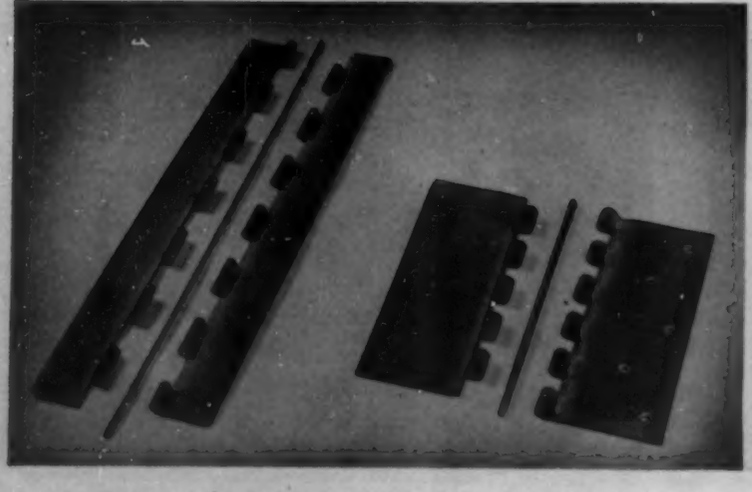

PHOTOS, COURTESY HAT CORP. OF AMERICA

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setting ester laminates, like that of the phenolics, is good.

In general, the phenolic resins produce tougher and more dimensionally stable structures than the urea type resin syrups, although it is possible to improve the toughness of urea laminates by a variation of the distribution of the resin within or on the surface of the fibrous sheet. It also is necessary, at times, to increase greatly the amount of resin applied to the fabric to produce a "mat" which is embedded in a mass of resin. In the latter instance, the resin content may be as high as 80 percent.

It should be remembered that the strength and toughness of molded laminates are a function of both the resin and the filler. In general, excess acidity of the resin should be avoided because of its tendency to increase the brittleness of cellulose fibers. Some thermosetting resins, when used to produce glass cloth laminates, produce excellent strength characteristics, while the same resins may cause embrittlement of cloth or paper-base laminates.

The effect of sizing in fabrics also has its effects on the strength of laminates. When a desired fabric was used with a phenol-formaldehyde resin, the tensile strength of the laminate, as compared with a laminate made with a sized fabric, increased 25 percent, and the impact strength decreased 30 percent. It is possible to increase the toughness by "sizing" fabrics with thermoplastic resins and bonding with thermosetting resins.

The bulk factor or density of the filler influences to some extent the minimum pressure that may be employed. In general, increased bulk means increased resin content to effect flow at any given low-molding pressure. Low-resin-content, high-density papers and tightly woven fabrics mold at lower pressures than the waterleaf type of papers or the open weave fabrics, although materials having a low density are likely to spread or fill out the contours of the mold better. This is especially so when molding into complicated shapes.

(*Please turn to next page*)

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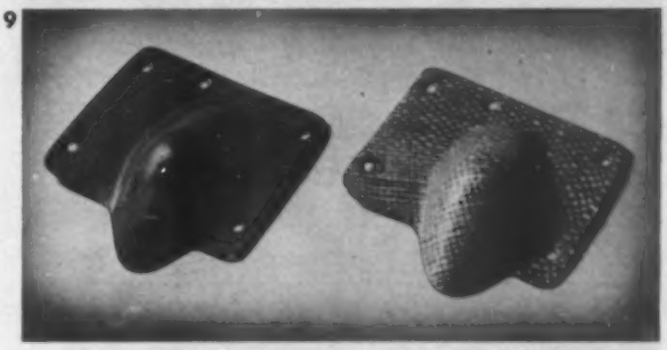

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8—Resin-impregnated P-18 cloth is used in the low-pressure laminated-molding of this aircraft fairing. 9—The aileron hinge fairing at right is molded of resin-impregnated sisal while that at left is of resin-impregnated P-18 cloth. 10—This wing tip fairing is still in the experimental stage. 11—This step assembly (bottom view) is molded of high-strength phenolic paper laminate. 12—An experimental, streamlined antenna housing. 13—A small radio locker case built to carry spare parts is of molded-laminated material and produced by low pressure methods

PHOTO NO. 8, COURTESY MC DONNELL AIRCRAFT CORP.
PHOTO NO. 11, COURTESY HAT CORP. OF AMERICA

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When the highest tensile strengths are required in a particular design, movement of the fibers is not permissible. In such instances, prepared shapes of the high tensile paper, glass cloth, etc., are assembled in the mold. Where high tensile strength is not a prime requisite, but speed in assembling the materials and in charging the mold is important, creped resin-filled paper, pulp forms, resin-fiber board preforms or a loosely woven resin-treated fabric may be used to advantage. This method also contributes a minimum of material waste.

Directional strength may be imparted by introducing strips of high-tensile paper, cotton threads or cords having very little twist, steel wire, glass fiber continuous filament thread or yarn, metal inserts, strips of wood, sheets of oriented cotton fibers, battings of oriented threads and fibers, and perforated metal or woven wire.

The knowledge, skill and ingenuity required by the laminator or molder in designing and preparing materials for low-pressure molded laminates might be compared to that exercised by the colloid chemist or the metallurgist, for there is a suggestion of organic and inorganic dispersions and phase relationships.

In Table II, mechanical properties are given for fiber-glass, paper and cloth laminates.

Low-pressure molding may also include the molding to shape, or forming to shape, at low pressures, of an article using a sheet of laminated material which has previously been molded at either a high or a low pressure. In the hardening, molding or curing of certain types of thermosetting resins, the polymerization for the initial fusible to the final hardened infusible stage will progress at a rate which makes it possible to stop the reaction during molding at a predetermined intermediate point to produce a material which may be fairly rigid at room temperature but pliable and somewhat ductile at elevated temperatures. The (*Please turn to page 144*)

TABLE I.—GENERAL TYPES OF RESINS USED IN LOW-PRESSURE MOLDING

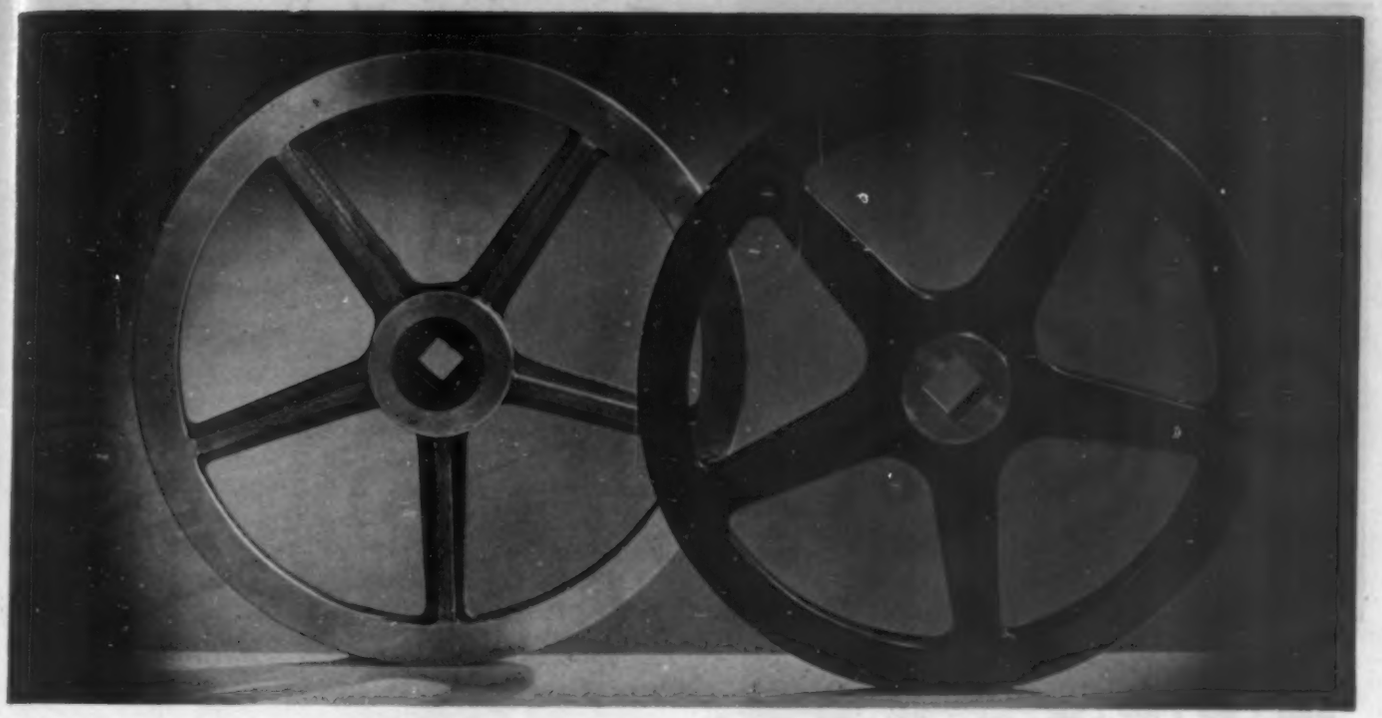
Resin class	*Resin type*	*Hardening temperature**	*Molding time*	*Molding pressure*
Phenol-formaldehyde	Cold-hardening	70–140° F.	30 min.–12 hr.	Contact—75
	Warm-hardening	140–220° F.	15 min.–2 hr.	Contact—250
	Hot-hardening	280–360° F.	5 min.–1 hr.	Contact—250
Amine:				
Urea	Cold-hardening	70–140° F.	10 min.–4 hr.	Contact—75
Thio urea	Warm-hardening	140–220° F.	5 min.–15 min.	Contact—200
Melamine formaldehyde	Hot-hardening	260–300° F.	5 min.–1 hr.	150–250
Thermosetting ester resins	Warm- or hot-hardening	140–325° F.	5 hr.–2 min.	Contact ($^1/_2$–2)

* The longer hardening periods generally refer to the rubber bag-autoclave process.

TABLE II.—MECHANICAL PROPERTIES OF CLOTH, PAPER AND FIBER GLASS LAMINATES

Type of filler	*8.6-oz. duck 78 × 28*	*8-oz. duck*	*Special sulfite*	*Special sulfite*	*Fiber glass* (4)
Type resin	Phenol formaldehyde	Phenol formaldehyde	Phenol formaldehyde	Phenol formaldehyde	Phenol formaldehyde
Molding time, $^1/_8$-in. panels, min.	8	8	8	8	8
Molding pressure, per sq. in.	100	200	100	200	250
Molding temperature, ° F.	310	310	310	310	310
Resin content, percent	52	52	37	37	50
Volatile matter content, percent	7.0	7.0	5.5	5.5	5.0
Specific gravity	1.31	1.37	1.37	1.40	1.65
24-hr. water absorption (1 × 3 × $^1/_8$") test piece	2.8	2.0	2.5	2.5	0.9
Tensile strength, p.s.i.	11,500	12,200	36,000 (1)	34,000 (2)	45,000 (3)
			18,000 (1)	17,000 (2)	
Flexural strength, p.s.i.	21,900	22,200	35,000	35,000	45,000
			20,000	20,000	
Modulus of elasticity	0.88 × 10^6	0.93 × 10^6	3.0 × 10^6	3.0 × 10^6	
			1.5 × 10^6	1.5 × 10^6	2.0 × 10^6
Impact strength, Izod, ft.-lb./in. of notch	A 3.8	4.0	0.8	0.8	16
	...	...	0.6	0.6	..
	B ...	...	5.0	5.0	16
	...	...	2.0	2.0	..
Compressive strength perpendicular to molding pressure	15,000	18,000	18,000	18,000	..
Percent elongation (tensile) 1 in. at fracture, percent	4.88	4.82	2.5	2.5	..

(1) Parallel laminated—machine and cross machine directions.
(2) Parallel laminated—machine and cross machine directions.
(3) Cross laminated—very thin cotton fabric bonding films between glass fabric.
(4) Continuous filament warp, thin cotton thread welt.
A. Edgwise.
B. Flatwise.



Molded fiber handwheels (right), varying in size from 5 to 25 in. in diameter are replacing aluminum valve wheels (left) on many of our newest destroyer

Down-East handwheels for destroyers

by W. E. PARSONS*

BUSIEST ship in the U. S. fleet is the destroyer. Small, light, speedy, she usually operates on the periphery of naval action, where Fortune is variable and the going heavy. Lacking the glamor of the flat top, the majesty of the battleship, the assurance of the cruiser, hers is the rôle of guardian to the more publicized units of the fleet.

As a member of a task force, the destroyer screens the larger, slower ships from enemy torpedos, directs anti-aircraft fire at attacking planes, plunges ahead to engage units of the opposing fleet. On convoy duty, she alternately fights off U-boats and urges her plodding charges along, rounding up stragglers and nosing them into line, and going to the assistance of those in trouble. As a patrol vessel, she operates stubbornly and doggedly on her own.

Since their appearance in the late 19th century, destroyers have grown in size from 700 to 2100 tons, and developed a concentrated power plant which has increased their speed from 27 to 37 knots. They are compact, resilient, tenacious and tough, and the materials which go into them must exhibit the same characteristics.

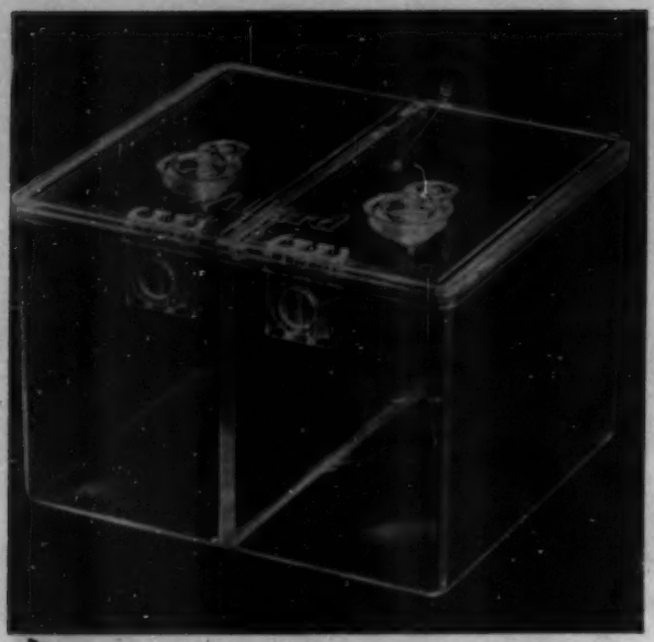
Longtime builder of destroyers for the U. S. Navy is the Bath Iron Works Corp., which has currently several of these warships under construction. Into each of them there went, prior to 1941, 1960 lb. of aluminum in the form of handwheels for operating the hundreds of valves with which such a vessel is equipped. Regulating valves in the steam, water and compressed air systems which are the nerves and blood vessels of the ship—firing her torpedos when she attacks, flooding her magazines when she is grievously hurt—these wheels step up in size from a 5-in. diameter unit to a large one of 24 in. diameter.

When aluminum grew scarce, both the Navy Department and the shipbuilder instituted a series of experiments with less strategic metals in an effort to replace the aluminum handwheels with others which would prove equally satisfactory. Wheels of steel, wheels of iron pipe with welded spokes, wheels of every feasible construction were tried and discarded because they were too clumsy, too ugly in appearance, too heavy or too expensive to produce. Best of the lot was a steel wheel developed by the Navy which was considered sufficiently adequate to be used during the winter of 1941–42.

No one was entirely pleased with the replacement, however, and one of the most dissatisfied was Chief Engineer S. H. Towne of the Bath works. After mature consideration of the problems involved, Mr. Towne came to the conclusion that the wheels could be made of some plastic material, and passed the suggestion along to William S. Newell, the company's president, who thought it a sound one and immediately began an investigation of plastics which might be able to do the job.

In 1941, our company developed a fibrous plastic material which has been used as a replacement for hard rubber, aluminum and sheet steel in such varied applications as parts for business machines, refrigerators and radios; electrical outlets and junction boxes; (*Please turn to page 138*)

* General Manager, Keyes Fibre Co.



PRODUCT DEVELOPMENT

Transparent battery housing

To insure fast, decisive action, the equipment of our armed services must be stripped of all excess weight and sufficiently rugged to permit extended separation from a repair depot. These 2 conditions were kept in mind in assembling a Walkie-Talkie for the Navy Bureau of Ships with wet storage batteries that withstand temperature changes and extended transportation better than dry-cell batteries.

Light weight was the principal reason for selecting polystyrene as the material most suitable for this non-spill wet battery housing. The transparency of this material allows the operator to see at a glance the level of the liquid. The plastic also inhibits creepage of the electrolyte and the collection of aciduous residue on the surface of the battery.

The container is molded in a $2^1/_2$-min. cycle in a single-cavity injection mold on a 12-oz. machine. Weighing $11^1/_2$ oz., the case is divided into 2 sections and marked on the side with a liquid level. The cover, injection molded in a 2-cavity die in a $1^3/_4$-min. cycle, has a grooved edge that fits snugly over the sides of the container. Two threaded holes and 2 vents are molded into this top. Removal of sprues and sprue markings plus hand scraping and trimming comprise the finishing.

Credits—Material: Lustron. Molded by Firestone Rubber & Latex Products Co. for Willard Storage Battery Co. for use in Walkie-Talkie electrical equipment by Electronic Laboratories, Inc.

Engine safety shields

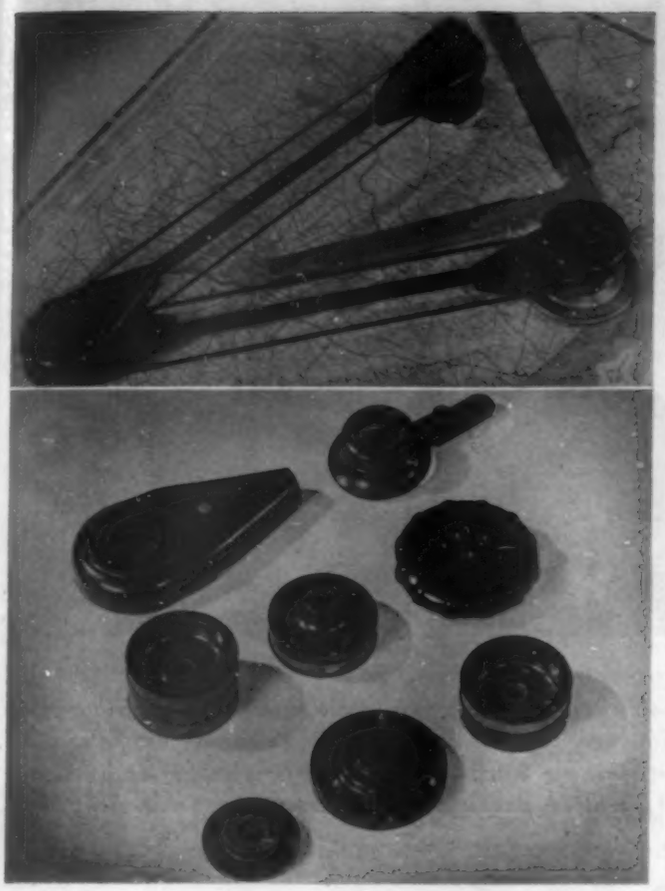
Safety devices for the industrial worker are common equipment in almost every factory. But protective shields designed to safeguard machines, not workers, are a recent development.

As engines for our M-3 and M-4 tanks and for Havoc attack bombers move along the assembly line, they are in constant danger from dirt and foreign objects dropping into the cylinders and other vital parts. As a protection for these incompleted motors, covers are fabricated of cellulose acetate to clip firmly into such openings as the exhaust stack, cylinder intake port, intake pipe hose connection and carburetor air inlet port, and to cover master and articulated rods.

These covers were made of aluminum and other metals until the demands of war production made these materials unavailable for such application. However, the cellulose acetate shields have proved their superiority. They are lighter in weight and consequently easier to handle. The transparency of the plastic permits the workmen to see inside the opening without removing the cover. With the adoption of cellulose acetate the problem of rust was abolished.

These covers are tailor-made in all sizes and shapes from sheets of cellulose acetate. Approximately 25 different shields now are being fabricated, the largest being the carburetor air inlet cover which is 16 in. by 8 inches. Replacement has been reduced, since the mechanical strength, toughness and wear resistance of the plastic permit repeated use of a single cover.

Credits—Material: Plastacele. Molded by Lurite Corp. for Wright Aeronautical Corp.



Light, accurate air plotters

A drafting or plotting instrument, to be of value, must retain its accuracy under extremes of temperature and over an extended working life. Such exactitude is of great importance to service men, considering that worn or distorted drafting parts will throw an aerial navigator's plotting miles off the target or reduce military drafts to useless sheets of paper.

In the redesign of this drafting machine, to insure necessary accuracy and stability, plastics were adopted. There are 4 distinct units to the equipment: the support arm which fastens to the drawing board or table, the elbow, the protractor assembly, and the right-angle scale. All parts are activated by steel tape used as a pulley. With the exception of the vertical and horizontal scales, the protractor, the base plate connecting protractor and scales, and the pulley tape, all parts are molded of rag-filled phenol-formaldehyde.

This plastic was selected for a variety of reasons. Its high impact strength made it suitable for the 4 pulley housings which are subject to much handling and repeated knocks. The 4 interior pulleys over which the steel tape slides suffer from constant friction and demand a high degree of toughness from their material. Phenol-formaldehyde, with flow characteristics that permit a fast molding cycle, gives a good appearance to the control knobs and reduces their cost. And, as a final advantage, use of this material trimmed $1^3/_4$ lb. from the over-all weight of the drafting equipment.

Credits—Material: Resinox. Molded by Windman Bros. for V. & E. Mfg. Co.

PRODUCT DEVELOPMENT

Brackets for sea markers

The patrol bomber sweeps low over the sea, identifying the tiny speck on the surface as a lifeboat crowded with survivors from a torpedoed tanker or crashed airplane. A sea marker is dropped to facilitate rescue by surface craft, and the bomber roars off. When our planes go out on their regular patrols they carry these markers mounted on brackets molded of tough, durable, canvas-filled phenolic material.

The material for the support is injected into a 2-cavity semi-automatic transfer mold through 2 gates located on 2 of the large points of the bracket. Transfer molding is used for the piece because it provides more economical finishing through the reduction of excessive flash.

In designing and manufacturing this piece, two difficulties had to be overcome. The stow bracket had a tendency to extreme warpage because of the heavy section along one side. This was remedied by the use of shrink fixtures which hold the part in its proper form while cooling. Also there was the problem of obtaining a good knit between the material entering from the 2 gates of the mold. The solution lay in the adjustment of heat and pressure, and in the balancing of the gates so that the material met adjacent to the center point

which is a heavy section in the piece. This brought the welding at the stronger point in the design. In order that any slight warpage which remains does not prevent proper assembly, holes are drilled on a jig in a secondary operation.

Credits—Material: Bakelite. Molded by American Insulator Corp. for Glenn L. Martin Co.

PHOTOS COURTESY E. I. DU PONT DE NEMOURS & CO., INC.

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***1**—Among the new nylon products now being used by our armed services are this heavy rope for gliders, the parachute harness webbing, parachute cloth for both cargo and escape, carburetor diaphragms and surgical sutures. **2**—New fields are being opened for postwar expansion by nylon film, insulated wire, coil springs, braided machinery packing, window screening and extruded tubing*

New forms for nylon

NYLON, so long associated in the public mind with toothbrush bristles and sheer stockings, is joining the ranks of molding and extrusion materials, film and coating solutions. For the duration, military needs are absorbing this plastic, but it will be made available to industry after the war in a wide range of useful forms.

Experimentation with nylon began in the du Pont laboratories 15 years ago and early results suggested the possibility of synthesizing a material made up of giant molecules from which fibers, large strands called "monofils," and plastics could be formed. Research and development work has now produced a thermoplastic material possessing the basic advantage of thermosetting plastics—high heat resistance. While most thermoplastics soften in the neighborhood of 160° F. (the highest softening point previously attained is about 280° F.), tests show that the present nylon plastic does not soften until the temperature rises to around 450° F., and it is expected that other nylon plastics having even higher softening points may be formulated.

Also, in spite of its extreme toughness, especially where sections must be thin and strength great, this is one of the lightest plastics, its specific gravity being 1.06–1.19 as compared with 1.27–1.56 for cellulose acetate plastic. Other advantages are its inertness to metal inserts, high chemical resistance, and the fact that it is easily machined and can be molded in existing presses with a few minor modifications.

The list of nylon plastic articles which are now in limited production or suggested for postwar use illustrates the great adaptability of this material. Bearings of nylon were the first strictly plastic application and experiments on various types are still in process. Water is said to be the only lubricant these bearings need under any condition and they require no lubricant for a light load at high speed or a heavy load at low speed. Whether they will be industrially important remains to be determined.

Extruded tubing is another plastic form which has proved valuable to the military, particularly for its toughness, flexibility and resistance to oils, chemicals and heat. Nylon in solution is currently used to insulate electrical wires, the wire being run through the coating at the rate of a mile a minute. In addition to good electrical properties, resilience and absence of fatigue make the plastic well adapted for this use.

Strips of nylon have been tested on outdoor furniture and found to stand up well against weathering and the effects of age. Smooth and easy to clean, nylon strips may also be used to cane bus, subway and trolley car seats. One application of the material's strength in thin sections is for zippers, at present still in the experimental phase. The homeowner will welcome plastic window screens which may be left in place all winter since they roll up and down like a window shade, will not stain the surrounding woodwork or corrode, and do not need to be painted, thus saving him two of his most tiresome seasonal chores. Of interest to the packaging industry is a nylon film possessing strength, air-tightness and high abrasion resistance.

While all this development goes on in hitherto untried fields of nylon application, the original uses of the plastic in fibrous form are being rapidly extended. Among many items these innovations include tire cords of high impact resistance, drapery and upholstery fabrics, lace curtains, and tapered paint brushes which wear at least three times longer than brushes made of pig bristles.

Tubing and tube fittings

by WM. M. WHITE*

PLASTICS promise to be extensively used in the piping systems of aircraft and in other applications, both during and after the war. During the last year, the use of plastics for aircraft piping has been seriously considered by several manufacturers. It is evident that such materials could be used in many applications, and the methods by which they are produced would save much of the time required to produce corresponding metal parts. The plastic fittings used would be 50 percent lighter, and the non-strategic tubing material would conserve a large amount of aluminum tubing.

Before a thorough investigation was made, several fittings made of a thermoplastic and of a design contrary to that of the present standard metal fittings made their appearance on the market. The cold-flow properties of the material and the non-standard design presented two major objections to these proposed aircraft fittings, which otherwise had abundant possibilities. The presence of cold flow meant that the fittings, when tightened, would cold flow into a state of looseness, thereby causing leaks in the system—an unsafe condition which is intolerable in aircraft. The non-standard design presented a fitting which could not be used with or substituted for metal fittings now in use. On the other hand, some emergency might necessitate the use of these non-standard fittings. Such substitution, in the case of other parts, already has caused serious delays and has grounded many airplanes at maintenance depots.

* Douglas Aircraft Co., Inc.

Although the advantages of plastic fittings in general overshadow their disadvantages, if care is not exercised in their use, serious consequences could result to both users and producers. It was thought, therefore, that the matter should be controlled with respect to materials, applications and especially designs by providing designers with information that will result in the maximum utility of the molds and parts produced therefrom.

It seemed that the best method of control would be through the National Aircraft Standards Committee, a body of aircraft representatives organized for the purpose of establishing aircraft standards. An inquiry was made of the NASC as to whether or not the subject was worthy of standardization, and the replies were almost unanimously in favor of proceeding with it as a project. The problem was assigned by the NASC to the Douglas Aircraft Company, Inc., and the writer was appointed chairman of the project, which became known as NASC Project P-230-1. While there were no officially appointed members of the Project Committee, all who commented were considered, to that extent, to be acting as committeemen. Members of the plastics industry contributed generously to this program in the preparation of specifications and test work.

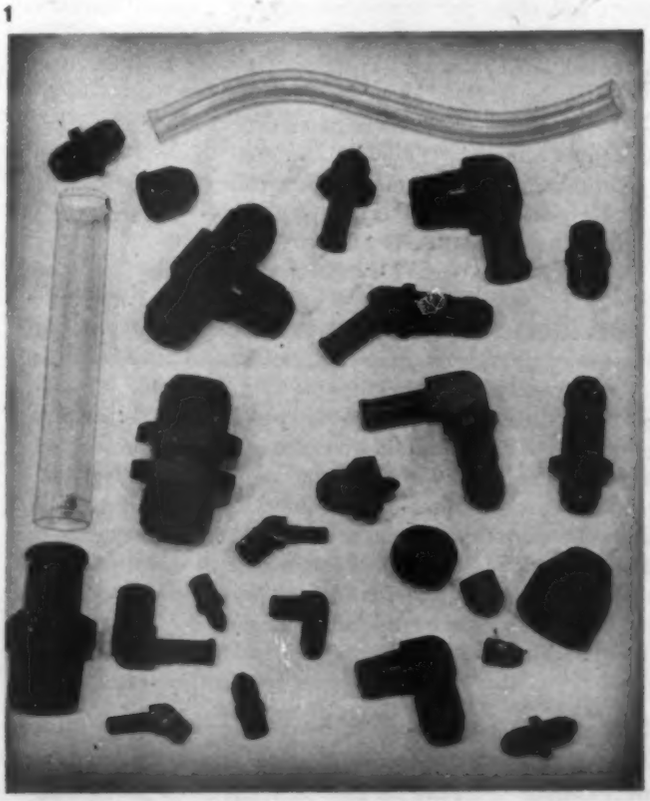
A test program was devised, consisting of two phases, for the following purposes:

Phase I.

a. Testing of fittings molded and machined of thermo-

1—A number of sizes and shapes of plastic fittings which have been fabricated in accordance with specifications are available for aircraft. 2—In tests to determine the stripping of threads, results showed that the threads were stronger than other portions of the body of the fitting

1



2

PHOTOS, COURTESY DOUGLAS AIRCRAFT CO., INC.

plastics for record and to determine the feasibility of using thermoplastic tubing with thermosetting fittings.

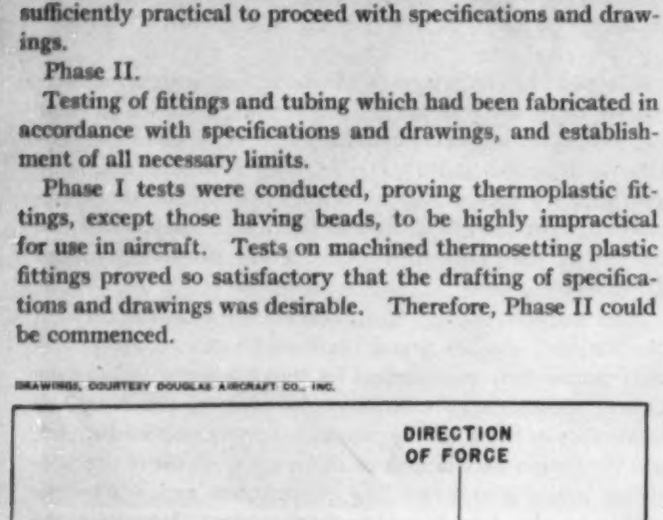
b. Production of fittings from thermosetting plastic slab stock, for necessary testing to determine if plastics were sufficiently practical to proceed with specifications and drawings.

Phase II.

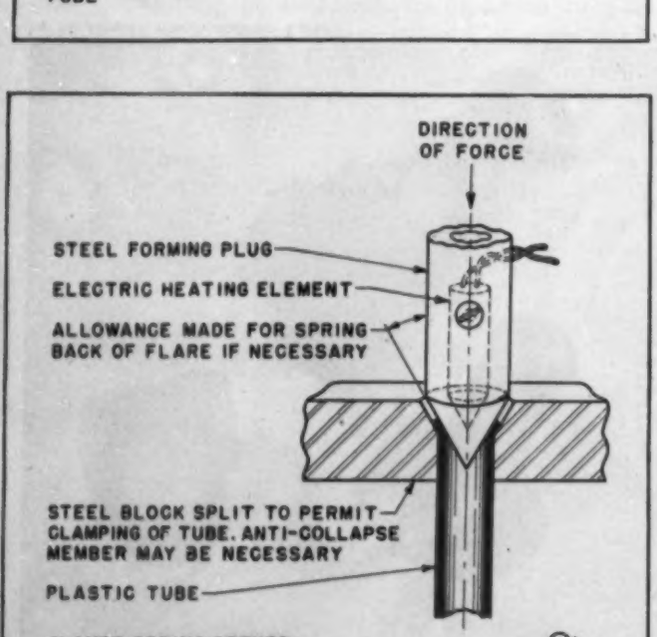
Testing of fittings and tubing which had been fabricated in accordance with specifications and drawings, and establishment of all necessary limits.

Phase I tests were conducted, proving thermoplastic fittings, except those having beads, to be highly impractical for use in aircraft. Tests on machined thermosetting plastic fittings proved so satisfactory that the drafting of specifications and drawings was desirable. Therefore, Phase II could be commenced.

DRAWINGS, COURTESY DOUGLAS AIRCRAFT CO., INC.


DIRECTION OF FORCE
ALUMINUM MANDREL ELECTRICALLY HEATED
STEEL RING PRESSED ON MANDREL
SPACE BETWEEN THESE PARTS PREDETERMINED FOR PROPER BEAD FORMING
STEEL BLOCK SPLIT TO PERMIT CLAMPING OF TUBE
STEEL GUIDE AND ANTI-COLLAPSE MEMBER
TUBE

3


DIRECTION OF FORCE
STEEL FORMING PLUG
ELECTRIC HEATING ELEMENT
ALLOWANCE MADE FOR SPRING BACK OF FLARE IF NECESSARY
STEEL BLOCK SPLIT TO PERMIT CLAMPING OF TUBE. ANTI-COLLAPSE MEMBER MAY BE NECESSARY
PLASTIC TUBE
CLAMPS SPRING OPENED FOOT LEVER CLOSED FOR RAPID PRODUCTION
FOR USE WITH EITHER FLARING OR BEADING TOOLS SHOWN ABOVE

4

Subsequently, work was begun on tentative specifications and drawings. Three specifications were necessary, one each for fabrication of fittings and tubing and one for installation of the finished fittings and formed tubing in the aircraft. The preparation of the specifications required many tests, as little was known regarding the limits of plastics. Even so, the specifications could not be completed, as further tests were necessary on parts made in accordance with the proposed standard drawings.

The most important requirements of the fabrication specification are as follows:

a. The minimum-maximum temperature range is listed. This must be done to avoid the use of inferior tubing which, if not controlled, might prove disastrous to this or any other proposal for use of plastics in aircraft.

b. The marking of all tubing, to identify the material, the extruder and the date on which it was extruded.

c. The identification of fittings, accomplished by molding in the NAS basic part number and the molder's symbol. The marking is a provision not heretofore incorporated on similar parts and is of definite value, especially in service procurement and handling. The inclusion of molder identification is very important in maintaining a standard of quality.

The installation specification controls the application of fittings and tubing, the general forming of tubing, wrench torque limits and similar data.

The preparation of the detail drawings of the 37 basic fitting shapes was much more simple, as it had been determined previously that, in the design, the following should be considered:

a. Because the design should embody maximum utility, the only logical system would be to make the plastic fittings interchangeable with the most popular metal standard now in use. The new Army-Navy standard is obviously the fitting upon which the plastic design should be based.

b. The design should be simplified to conform to molding practices by modification of certain dimensions and tolerances.

Upon approval by the NASC, NAS drawings and specifications become standards. NAS numbers are assigned and reprints and other pertinent information are issued thereafter by the Office of the national chairman, NASC, care of the Aeronautical Chamber of Commerce of America, Inc., Washington, D. C.

This project has been coordinated with the following standards organizations:

National Aircraft Standards Committee (NASC)
Society of Automotive Engineers, Inc.
American Standards Association
Working Committee of the Aeronautical Board (Army and Navy)

A number of fitting shapes have become available through emergency aircraft requirements, and several have been used in tests to determine the stripping of threads (Fig. 2). The results of the tests are amazing, as there has been no stripping of threads. These threads are in shear and have proved to be stronger than other portions of the body of the fitting. It is believed that the thin section of the threads permits a "cure" more thorough than that in thicker sections, thus causing the additional thread strength. In the case of metal parts, the threads are usually the weakest region in the part, damage of which is prevented by controlling torque on wrenches. Torque values will also be established for plastic fittings.

3, 4—*Simplified methods of beading and flaring fittings. Heat is applied to internal members only, and it is not necessary to decrease the heat before removing the member*

Because of limiting characteristics of the plastic materials at the present time, it is proposed that the applications in aircraft be limited to those where the temperature will not exceed 200° F. This is considered quite conservative, since the bursting pressure of 1-in. O.D. tubing with .062-in. wall thickness is approximately 200 p.s.i. at this temperature. Permissible applications include apparatus for carrying de-icer pressure, instrument vacuum, instrument static pressure, certain hydraulic oil and various drain and vent lines. These would amount to approximately 20 percent of the piping systems in an airplane having all of these systems. Plastic fittings have insulating properties in that they retard the transfer of heat. These fittings will withstand considerably more pressure and heat than will the tubing, which means that the tubing is the limiting factor in uses other than those proposed. "Cellulose acetate butyrate H2 flow" is the tubing most applicable at the present time. It is estimated that the future development of materials, especially for tubing, will permit the use of plastics to reach 50 to 60 percent of the total tubing in aircraft piping systems, provided of course, that none of the above-mentioned systems is eliminated.

It is believed by some authorities that the fittings embody sufficient strength to permit their use with soft aluminum tubing. Testing of this combination will determine the feasibility of mixing materials in one system to this extent.

Plastic fittings can be produced in from 50 to 80 percent less time than that required to produce the corresponding aluminum fittings; this is possible because of the use of multiple cavity molds and new molding methods, and the fact that the parts require little or no finishing after removal from the molds. This saving of time will result in faster delivery to assembly lines. The use of plastics provides new and additional sources for aircraft fittings and tubing from an industry heretofore not extensively engaged in producing such equipment. These new sources of procurement may alleviate to some extent the burden on metal fitting and tubing producers. The plastics industry realizes that this program is in competition with aluminum for the applications proposed, and probably every effort will be made to produce at the lowest level of cost and also continually to increase the quality of the materials. It is estimated that the fittings will cost approximately 75 percent less than corresponding aluminum parts. Extruded plastic tubing will be approximately 25 percent lower in cost than aluminum tubing.

Use of plastic fittings in place of aluminum represents a weight saving of approximately 50 percent—a very important item in aircraft, as the elimination of each parasitic pound is a gain of many hundreds of cargo dollars or greater travel distance over a year's operating period. There is not so great a weight saving in the plastic tubing; only about 5 percent is eliminated, since the wall thickness is increased to approximately double that of the aluminum tubing.

The use of plastic tubing as compared to aluminum tubing presents a time saving of approximately 50 percent in forming, flaring, and end beading operations. This saving is realized because operations upon plastic tubing require no complicated machinery, such as must be used with aluminum tubing. Even the flaring and beading tools are amazingly simple (Figs. 3 and 4). By softening the tubing through the application of uniform heat (approximately 210° F. at the area to be bent), it may be bent around a wood form block. No particular method of heating is recommended, as there are several methods now in use and more improved methods will be discovered as more experience is gained.

Some of the present heating methods are as follows:

1. Oven with spring-closed door adjacent to the form block.
2. Insertion of steam hose (slightly smaller than the tube I.D.), with either internal or external application of heat.

At the present time, it appears that the best method of forming in production would be to construct flexible jigs. Such a jig may consist of a wooden base board and felt-lined clamps having telescopic legs hinged for attachment to the base. The legs have thumb-screw clamps to accomplish desired lengthening and shortening. The hinged brackets are readily attachable or detachable by screws. This flexibility permits speedier original set-up and adjustment; also, when production for a particular jig set-up reaches its end, the jig components can be reassembled for other tube forms. With such a jig, the tube is completely softened, placed and clamped in the jig while still soft, and allowed to set.

In the forming operation, it is necessary to permit a temperature drop of 5° or 10° before relaxing the bending effort. More spring-back exists in the plastic than in aluminum tubing. However, this condition makes the matching with templates less critical, as the tubing can be sprung into place at assembly better than may aluminum, because of its greater resilience.

Care should be exercised to avoid subjecting the tubing to excessive heat between the time it is formed and the time it is installed, due to its inherent "plastic memory." It has been determined that there is no significant spring-back in temperatures up to 90° F.

The possible efficiencies outlined above will not be realized if the forming operations are not handled properly. These operations should not be performed by a department which has previously been doing similar work with metal, unless the department's personnel is willing to avoid the association of metal working methods with plastic forming methods. It is not likely that benefit will result from using the old methods on the new materials. On the other hand, a new, progressive group will develop methods more efficient than those heretofore. It has even been suggested that perhaps a better, cheaper and faster means for forming tubing would be to subcontract such operations to plastics firms which are already familiar with this type of work.

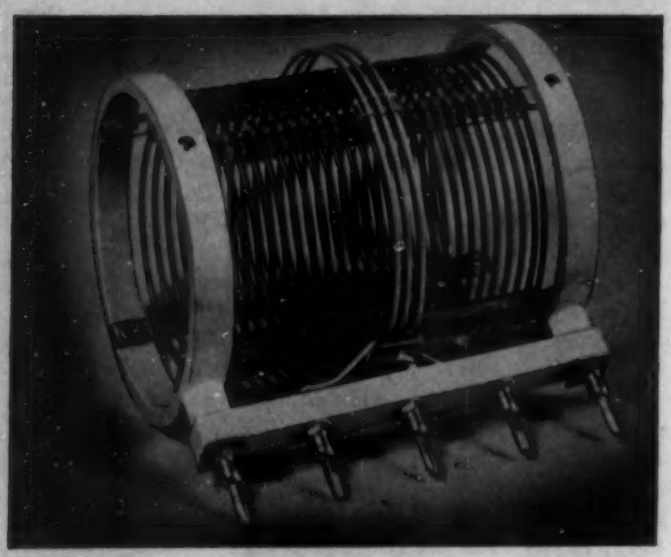
Plastic tubing has other advantages in that it can be reworked and re-formed repeatedly without impairing its effectiveness, thereby reducing scrap to a minimum. It can be spliced by the use of cement and a doubler made from a short section of tubing of a size larger or smaller. Clips and brackets can be attached by cement wherever required. A scratch or blemish may be repaired with cement.

In consideration of the present rate of aircraft production, it is estimated that several million linear feet of aluminum tubing could be saved annually by replacing it with plastic tubing. This, of course, is possible only if plastic fittings are available to connect the tubing. Metal fittings are not recommended for use with plastic tubing, because the heat transfer from the metal to the plastic tube flare would encourage plastic flow of the tubing at higher temperatures.

The part this program will play in the aircraft industry after the war has been considered thoroughly. This is not merely a wartime standard. Its inception before the war, however, would have been of considerable value to the war effort. The specification on plastic fittings and tubing was written in such a manner that plastic parts other than those mentioned in the proposed standards could be made in accordance with the specifications. The specification also permits its use by any and all industries desiring to use this plastic series. There is no restric- (*Please turn to page 150*)

PLASTICS IN REVIEW

1 You can be a "four eyes" and enjoy safety while at work thanks to Watchemoket Optical Co. These all plastic goggles, strongly reinforced with a metal clip at the bridge, are designed to fit over prescription glasses and have ventilating holes to prevent fogging. Weighing but 1¾ oz., the frame permits the easy replacement of the Plexiglas lenses



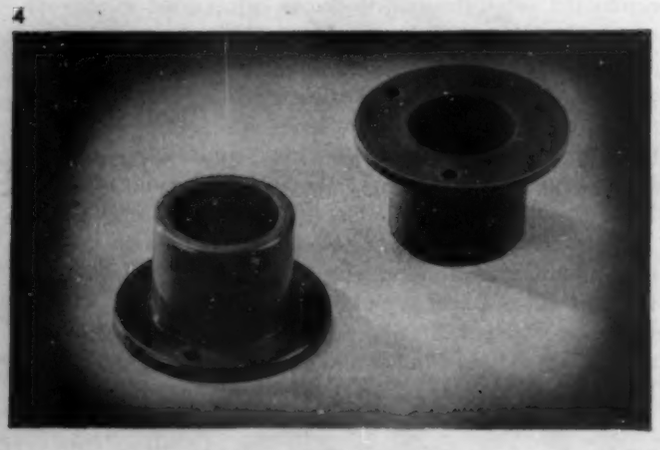
2 To insure perfect insulation, bars of transparent Plastacele extend the full length of this air core, induction coil at 4 different radial points. The good electrical and mechanical properties of the material make it the perfect insulation for these radio coils, ranging in size from 1 in. in diameter by 2 in. long up to 1⅝ in. in diameter by 2⅛ in. long

3 In the practice of cleanliness, initiative too often stops with the soap and leaves an unattractive, tarnished soap dispenser. Not only is the Lumarith holder at left corrosion resistant and easily cleaned, but it is considerably lighter in weight than its metal counterpart (right) partly because of the ribbed construction of the wall bracket. The seven plastic parts of the dispenser are injection molded by Amos Molded Plastics

4 Every part, down to this red Lumarith salvo release switch guard, must be functionally perfect when Glenn L. Martin bombers start their run over an industrial target in Axis-held territory. Using 28.5 grams per shot, these guards are molded by Bachmann Bros., Inc., in a 16-sec. cycle under 900 lb. pressure in 2-cavity molds on 1-oz. H.P.M. presses. No finishing operation is required beyond removal of gate and runners

5 While a teaspoon may be more appropriate for the dispensing of sugar, this cellulose acetate scoop is applicable to the handling of flour, powder or industrial compounds. Replacing a sand-cast, polished aluminum scoop, the piece is molded by Pyro Plastics Co. in a single-cavity mold, the hollow handle being acetoned to the scoop after molding. The piece weighs but 7 oz. and is distributed by George Walter Davis

6 To save the time and strength of America's hard-pressed dairymen, an all metal portable milking machine pulsator (top) was redesigned with 2 dual cylinders, 2 connecting rods and 2 sliding valves compression molded by Textolite. The use of plastic for these parts reduced the weight of the unit shown at bottom by over 1 lb. and increased its effective working life. The pulsator parts are molded by General Electric for Rite Way Co.



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7 Not only a soldier but his equipment must be able to take it. This right-angle, 2-cell flashlight molded of Lumarith is capable of withstanding temperatures ranging from −40° to 175° F. and of continuing to operate when submerged in water. In designing this light, care was taken that the threads mesh with older metal parts, thereby simplifying the problem of replacement. Molded by Gits Molding Corp., Bright Star Battery Co. and Worcester Molded Products Co. for U. S. Electric Mfg. Co., and by Mack Molding Co. for Micro-Lite, Inc.

8 The public's stockings and trousers may droop for want of elastic suspenders and garters, but a new elastic-type Vinyon yarn has solved the problem for members of the Armed Services. Lacking the rapid snap-back of rubber or latex, this yarn can be made with an elongation ranging from 150 to 400 percent at temperatures varying from 0 to 75° C. Used now for knee braces, heavy duty suspenders for aviators' suits (as pictured), hammock suspension cords and elastic garment tapes, the yarn shows promise of extensive postwar use in surgical stockings, girdles and hosiery tops

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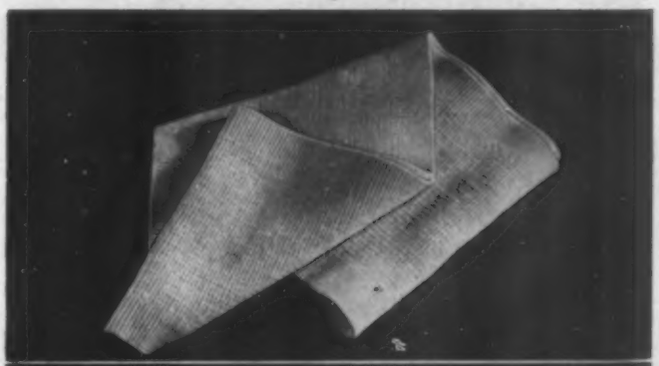

9 While the hazards of a bugler's life remain in the hands of millions of sleepy soldiers, those of the Army fife player have been virtually wiped out by this Tenite fife extruded by Penzel Mueller Co. for the U. S. Drum and Fife Corp. Because of the low heat conductivity of the plastic, the player's lips no longer are in danger of freezing to the instrument in cold weather. When it is subjected to extremes of temperature and humidity, the low moisture absorption and composition of the plastic prevents swelling and cracking as in the case of wood fifes. Despite a thicker wall which gives the Tenite fife louder and more penetrating tone, it weighs but 2.8 oz.

10 All military equipment must withstand heavy shock and impact, all types of weather and atmospheric conditions. These special types of containers are fabricated of Durez resin-bonded plywood by Red Lion Cabinet Co. to meet such requirements. Low temperature resin adhesive is used to coat dovetailed joints and mortises thereby increasing the normal strength of the joints and eliminating the need for extra metal reinforcements which otherwise might be needed

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PHOTOS COURTESY H. J. HEINZ CO.

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1—Except for the metal part in the foreground, these airplane fairings were formed from Grade C phenolic laminated sheet by post-forming. The metal fairing weighs 60 grams, the 1/16-in. phenolic part 45 grams and the 1/32-in. fairing 23 grams. 2—A miscellaneous group of industrial parts all made by the post-forming method.

Post-forming thermosetting products

THERMOSETTING materials have been defined as those with the property of undergoing a chemical change when heated whereby a hardened product is obtained. Now it would seem that this definition may be due for a change. The H. J. Heinz Co. recently announced the development of a method for molding or post-forming phenol-formaldehyde laminated sheets after they have reached the stage where formerly they were considered definitely thermoset and impossible to remold and shape. While only the high lights of this new process now can be divulged, MODERN PLASTICS will carry a full description at a later date.

Since the outbreak of war the Heinz Co., well known for its 57 varieties of food products, has added plywood and plastic airplane parts to its production schedule. Laminated sheets containing such fillers as paper, glass fiber, cloth and asbestos impregnated with phenol-formaldehyde resin are employed. Since the possibility of shaping and reshaping the material during the process of lamination is very limited, the company's research department headed by Dr. P. K. Porter began experiments with a view to making complicated shapes such as airplane wing tips, nose pieces, access doors and fairings.

The shaping process developed from this work is a low-cost operation using wood molds. It has been reported by the Heinz company that no air-conditioning is required, and the forming can be done with cold molds at very low pressures of approximately 10 to 60 p.s.i. To find the effects of this post-forming on the laminated (*Please turn to page 140*)

TENSILE TEST OF PHENOL-FORMALDEHYDE LAMINATED SHEET**

		Original size in.	*Original area sq. in.*	*Load at .02 in./in. extension lb.*	*Loading time sec.*	*Maximum load lb.*	*Mean rate of stressing lb./sq. in./sec.*	*Tensile strength p.s.i.*	*Elongation in 2 in. in.*	*Elongation percent*
Cotton duck base, Grade C:										
As received	(1)*	.502 × .0893	.0448	355	82	415	97	9260	0.05	2.5
	(2)	.490 × .0913	.0456	335	90	405	82	8880	0.06	3.0
As treated	(1)	.493 × .0903	.0445	315	88	337.5	80	8480	0.05	2.5
	(2)	.494 × .0934	.0461	350	96	375	79	8140	0.04	2.0
Formed and reformed	(1)	.492 × .0921	.0453	290	92	377.5	70	8340	0.04	2.0†
	(2)	.493 × .0933	.0460	310	78	405	86	8800	0.05	2.5
Linen base, Grade L:										
As received	(1)	.490 × .0582	.0290	265	48	282.5	190	9740	0.03	1.5
	(2)	.497 × .0550	.0273	235	47	262.5	183	9620	0.04	2.0
As treated	(1)	.498 × .0585	.0291	252.5	45	275	193	9450	0.04	2.0
	(2)	.494 × .0580	.0287	250	52	250	168	8710	0.05	2.5
Formed and reformed	(1)	.496 × .0582	.0289	252.5	50	270	175	9350	0.04	2.0
	(2)	.494 × .0580	.0287	255	52	275	170	9580	0.04	2.0

* (1) and (2) represent two samples tested.
† Broke outside of the elongation marks.
** Test conducted by Pittsburgh Testing Laboratory.

Molding vinyl copolymer dentures

by ARTHUR W. BROWNE*

ONE of the recurrent problems of modern dentistry has been the difficulty of obtaining properly fitting dental plates. For decades hard rubber was the only organic material available for artificial dentures. Opaque, unattractively colored, and susceptible to the effects of oils, fats and greases, it disappointed the fastidious public and chemists sought for a substitute which should be at once more chemically inert and also more natural looking. Experiments with cellulose nitrate compounds showed that although they were translucent and capable of being tinted in lifelike shades, they were easily warped and discolored. The late twenties and early thirties saw the production of phenol-formaldehyde artificial dentures which were fairly successful. However, those materials were found to be somewhat brittle and lacking in color longevity.

The next step was the use of methyl methacrylate or acrylic resins, first developed in England and Europe in the early thirties and in this country in the late thirties. Since they possess long color life, resist the action of acids, alkalis, greases, fats and most solvents, and are easy to process, these materials have been widely adopted in the United States. However, they are affected by alcohol, and they have certain other limitations.[1]

One of the newer dental materials[2] is a selected vinyl copolymer plasticized with a suitable monomer—preferably methyl methacrylate. This modified vinyl copolymer compound is said to be insoluble in acids, alkalis, greases and fats, as well as alcohol and all liquids taken internally. Not only does it possess the advantages of lower initial curing shrinkage and negligible water absorption, but its toughness has been demonstrated to be exceedingly great thus guarding against the breakage of dentures made in thin sections, and damage to partial plates which previously had been found to be quite fragile.

Coincident with the development of this new base, there has evolved an improved techinque for processing dentures made from it, substituting injection or extrusion for the compression molding process. By the usual method of compression molding, the material is poured into a plaster mold contained in a flask. In order to charge the mold, the flask is split in half and when charged, the 2 halves are squeezed together in a press. This results in the production of a fin between the halves which creates an error causing what is known as a "raised bite." After molding is completed, this error often makes it necessary to cut down the cusps of the teeth in order to make the denture fit. For years efforts have been made to reduce this "raised bite" error by making dentures in a closed flask by injection or extrusion. The new technique described below requires careful control of the flowing and curing characteristics in order to inject this material success-

* Chief chemist, Luxene, Inc.

[1] "Acrylic Resins for Dentures," MODERN PLASTICS *19*, 61 (April 1942).

[2] Marketed under the trade name of Luxene "44," and developed by the Bakelite Corp. and by Carbide and Carbon Chemicals Corp.

PHOTOS, COURTESY LUXENE, INC.

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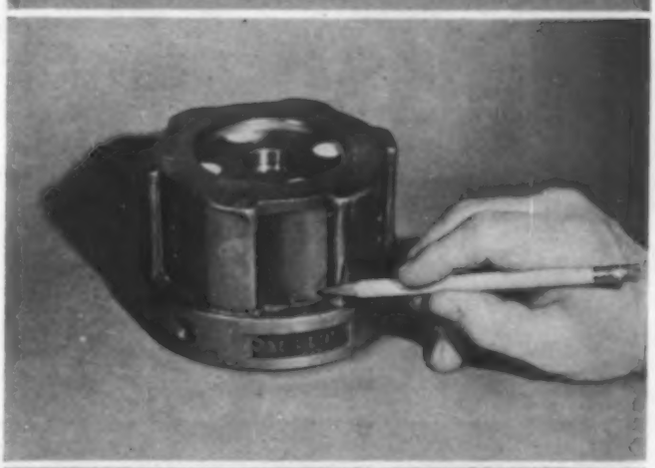

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1—The edges of the metal flask are machined for a watertight fit. 2—Only a small charge is put into the mold. 3—After being fitted together, the 2 halves of the flask are placed in a "cage." 4—The modified vinyl copolymer compound is admitted to the mold through a small sprue

PHOTOS, COURTESY LUXENE, INC.

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fully under nominal pressures of 60 to 70 lb. per sq. in.; it also requires special equipment to accommodate the material.

Molding modified copolymer denture base material

A rigid metal flask which withstands wear and distortion is used. It is carefully machined so that the edges of the 2 halves meet for a watertight fit (Fig. 1).

In molding, only a small charge is put into the mold, considerably under its capacity (Fig. 2). When the 2 halves of the flask are fitted together, the flask is placed in a large nut or "cage" and tightened with a spanner wrench so that the underpacked flask closes completely with metal-to-metal contact. The pressure is applied around the entire rim of the flask, and this holds the flask uniformly tight, preventing leakage of the material from between the halves (Fig. 3).

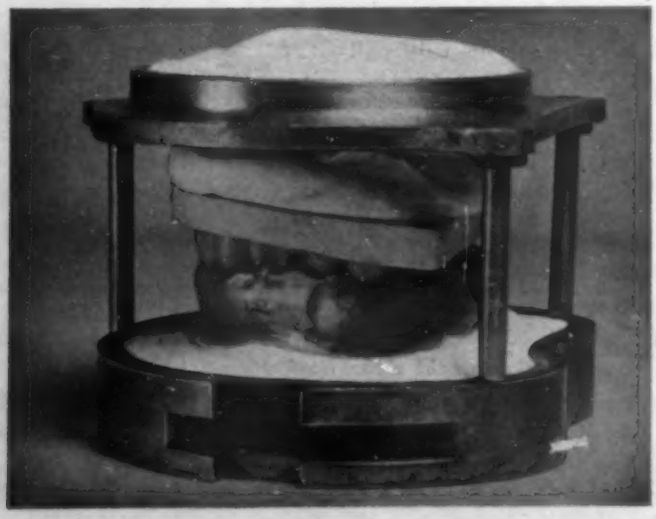
The material is admitted to the mold through a small sprue opening from the center of the denture to a nozzle. After the nozzle has been charged (Fig. 4) and the ram or piston is fitted into place (Fig. 5), the gun equipped with a calibrated spring is screwed to the nozzle (Fig. 6) applying pressure on the ram. The assembly (Fig. 7) is then placed in boiling water.

In a few minutes the resin will soften and flow through the sprue into the partly filled mold. Steady pressure is maintained by screwing the gun barrel against the ram until the mold is filled. This is determined by an indicator at the top of the gun barrel. The material is then cured at 100° C. for $1^1/_2$ hr. until complete polymerization has taken place. Maintaining pressure on the resin during the early stages of cure results in reduced gas bubbles and also more accurate reproduction of the original dimensions of the denture. Furthermore, since the flask or mold was closed when only partly filled, practically no fin or flash can occur (Fig. 8).

A simple check on the maintenance of the bite relationship is made with a device called a "Tru Check." The Tru Check is mounted on the wax denture in the flask before processing, as shown in Fig. 9. After the denture has been processed, the Tru Check is remounted in the same position, and the maintenance of these dimensions is recorded by complete seating of the 3 legs of the Tru Check in their original position.

5—After the flask is charged, the piston is fitted into place. 6—A gun with a calibrated spring is screwed to the nozzle. 7—Fully assembled, the mold is ready for immersion in boiling water. 8—The dentures produced by this method show that practically no flash occurs. 9—A check is made on bite relationship before processing

9



Plastics ENGINEERING
F. B. STANLEY, Engineering Editor

Molding curved plastic-plywood*

by THOMAS D. PERRY†

CURVED plywood has been made for many years and used in furniture, pianos, radio cabinets, doors, stair risers and the like. The volume has been quite limited, the devices for obtaining curvature have been relatively simple so that it could be made by the factory mechanic and the strength/weight ratios were not considered important. Improved methods for producing curves out of prebonded flat plywood, as well as of making curved shapes at the time the layers of veneer are glued into plywood, have both been in the stage of progressive development but, until quite recently, without evidence of particular urgency. An earlier paper[1] ** by the author, in comparison with the present paper, gives an interesting perspective, indicating the marked progress which has been made in the technique of curved-plywood manufacture.

The distinct realization of the outstanding utility of curved plywood of complex shapes for aircraft, boats, Signal Corps requirements and other fighting equipment has given substantial impetus to these developments, and the progress made in the past two years has been most striking. Since plywood materials, equipment and man-power were found to be relatively plentiful, its adoption as an alternate for scarcer and more critical metals has greatly accelerated the development of new methods of pressure application for making intricate curved forms of plywood and related materials. The availability of heat-reactive resin adhesives has become another major factor in this expanding plywood program.

At this time, it is possible to examine the principles underlying this new curved-plywood technique, to evaluate them at least partially and to outline some of the more important methods which have so far contributed to its rapid progress. The program is making such strides that statements of today may be untenable tomorrow, and the visions of this week may become the facts of next. An outline of such industrial progress, as it occurs, needs no defense, nor does its obvious incompleteness require an apology.

Pressure in one direction

The standard method of exerting pressure, when gluing sheets of veneer into plywood, has been the application of pressure in one direction only, i.e., by hydraulic rams or pistons, by pneumatic jacks, by screw presses or clamps and, in rare instances, by toggle joints. Such pressure is distributed, more or less efficiently, over the area of the glue joint by rigid plates or blocks. This method of pressure application involves adjustments or corrections for certain inevitable dif-

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** This and other important references to technical publications on the art are given in the Bibliography at the end of the paper.

1—Diagram for vertical pressure, indicating effect of curvature on unidirectional pressure, i.e., pressure at B is ²/₃ that at A, at C is ¹/₂ that at A, and at D is nil. 2—Omnidirectional pressure. Diagram indicates that the flexible bag exerts pressure in every direction, and its intensity is equal at A, B, C, D, E and other points. Vents are provided at F. Overlays are shown at G and H

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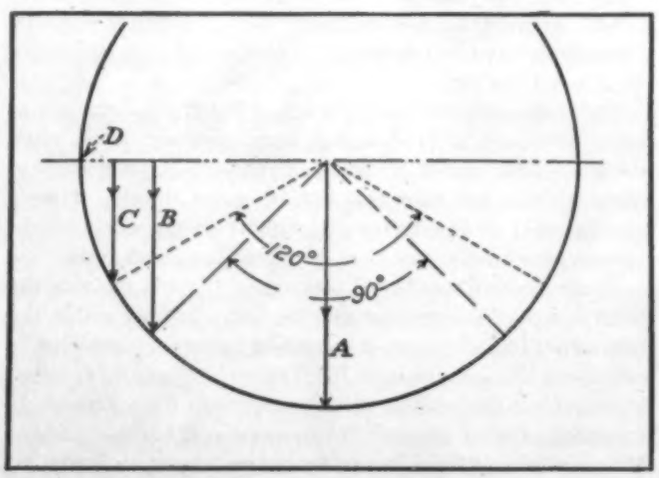

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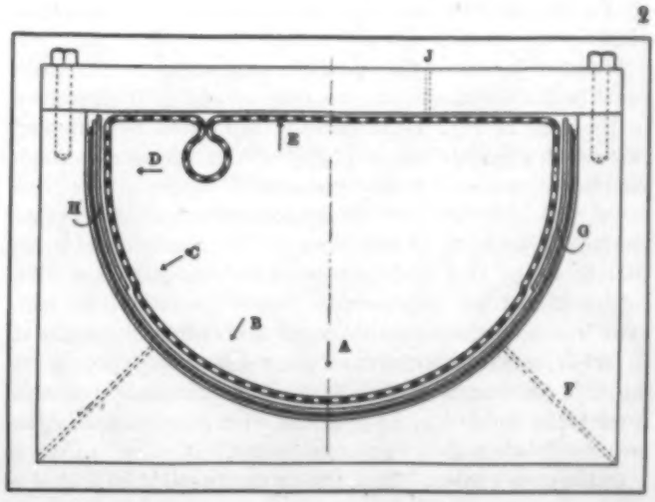


ferences of thickness which are common to all wood products and are suggested by the following examples:

Veneer lathes and slicers are equipped to cut certain fixed thicknesses, often from logs or flitches which are cooked to the saturation point. It is well known that the shrinkage from such a saturation point, or from normal greenness, to working dry (approximately 10 percent moisture content) will differ, as between quarter-cut (radial) and plain-cut (tangential), and also will vary between sapwood and heartwood. Furthermore, there is no generally recognized standard for veneer-cutting. Some operators cut to full dimension green, resulting in a scant thickness dry, while others allow a fixed shrinkage factor and claim to produce veneer of full dimension when dry. Another phase of the problem is that rough-cut surfaces require more pressure than smooth-cut veneer.

The practical solution to thickness variations, in regular plywood production, is adequate pressure to compress the thicker layers until they match the thinner layers, usually a reduction of 5 to 10 percent in aggregate thickness being required. This involves the use of more pressure than is needed otherwise and requires the allowance of extra initial thickness in the veneers used.

Another problem in the use of one-directional pressure is that of somewhat curved or recessed surfaces, such as the well-known "Toastmaster" plywood tray, or a conventional barrel stave of plywood. In order to make a proper plywood bond, effective pressure should be exerted in a direction at right angles to the curved surface, or perpendicular to a tangent. Vertical pressure, diverted at an angle, will be reduced in geometric ratio, as can be noted in Fig. 1, which is a diagram published in the original paper.[1] Full pressure (e.g., 100 p.s.i.) will be exerted at *A*, while at the extremities of a 90° angle (as at *B*), the pressure will be of the order of two-thirds; at the extremities of a 120° angle (as at *C*), it will be one-half, and at *D* it will be nil. From a practical viewpoint, one-directional pressure can be made effective over a 90° angle, sometimes over a 120° angle, but there will be a moderate amount of surplus pressure required to compensate for the effect of the curvature.

There are some instances, relatively few in number, where presses or clamps exert pressure in two directions, as in a vertical and horizontal direction, but, in general, these two-way-pressure devices are not important.

Pressure in all directions

With this background in mind, it is possible to contrast the one-directional pressure through rigid plates, as outlined, with the recent developments in applying flexible pressure with a fluid medium, such as steam, hot water or compressed air.

Figure 2 indicates the same plywood construction which could be made with the pressure diagram of Fig. 1. However, in the case of Fig. 2 the pressure is exerted by inflating, through *J*, a flexible bag, as of rubber. As a result it is omnidirectional and with a fluid pressure of 100 p.s.i., it will be noted that this full pressure without any diminution is effective at *A*, *B*, *C*, *D* and even at *E*. Another result accomplished by this fluid pressure is the elimination of difficulties caused by variations in veneer thickness. In fact, extra layers of veneer can be placed at certain locations, as at *G* and *H*, where concentrated stresses may be expected for fastening devices or scarfed joints. If a heat-reactive resin is used, the molds may be provided with steam pipes, or the pressure fluid may be steam or hot water.

In the cross section, Fig. 2, the curvature might be that of a semicylinder, requiring curves in one plane only, or it might be a semisphere or semioval involving compound curves in more than one plane. This latter shell-shape construction has been called "monocoque," and its best example is an egg shell, where strength/weight factors are found to have distinct advantages. In many monocoque designs, bracing or stiffeners are found to be effective in improving strength characteristics, with less total weight than when the shell is thickened throughout for localized stresses. Such braced shells are called "semimonocoque."

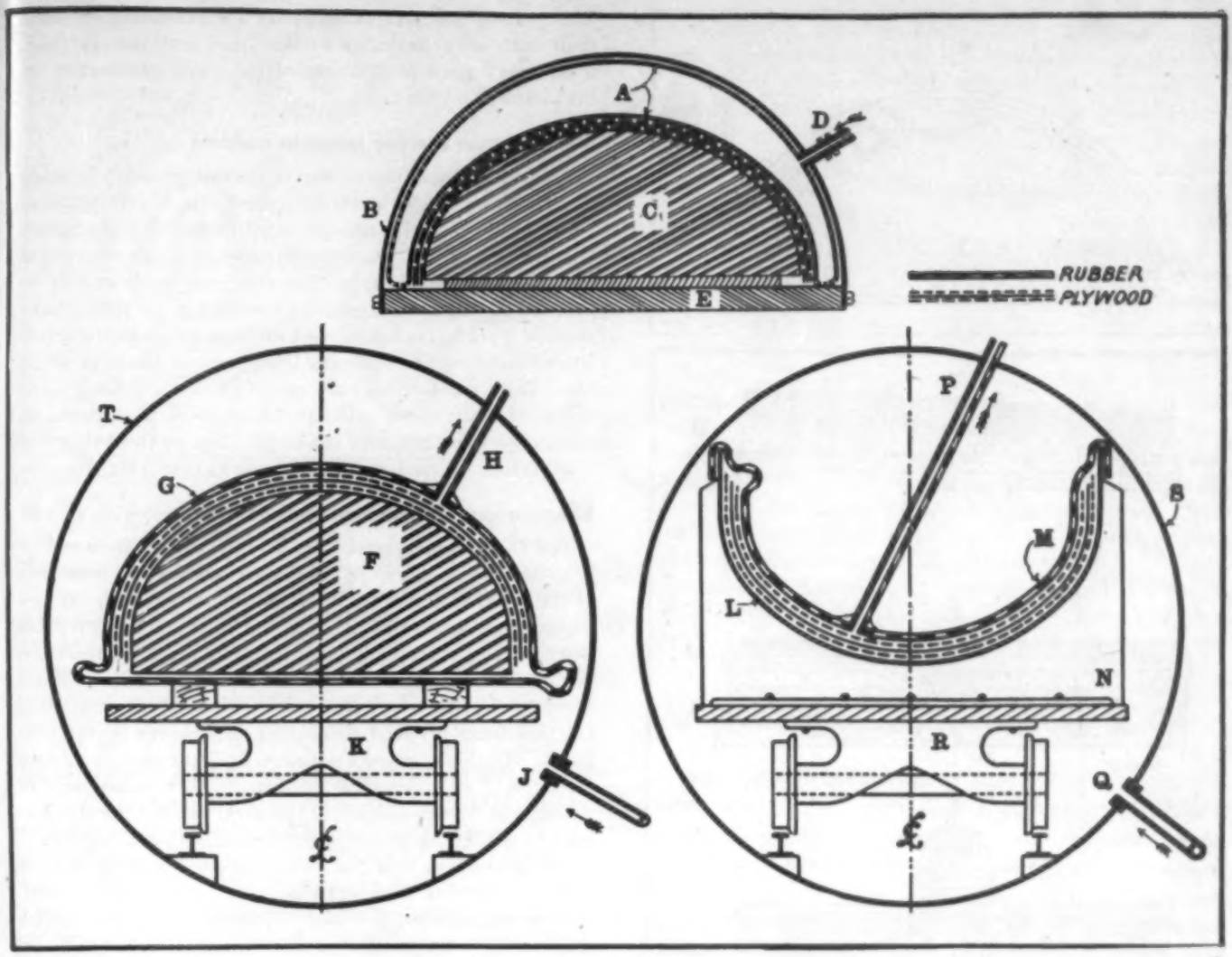
Methods of applying omnidirectional pressure

There are at least three principal methods of making monocoque plywood with flexible pressure bags: a) inflatable closed bag or mattress not containing the plywood; b) deflatable open-end bag containing the plywood; and c) deflatable half-bag, or blanket enclosing the plywood, in which the mold constitutes the other half of the bag.

In order to facilitate their comparison, Fig. 3 illustrates the same plywood shape made by each of these three processes. The cross section of this shape in the sketches might be one-half a fuselage or a boat hull. In the case of the fuselage the two halves would be scarf-jointed and bonded into a whole. The shape as shown is intentionally reduced to its simplest form, and actually represents a cross section, in simple curvature, of a cylinder or cone. In practice, this will probably have a considerable amount of compound curvature, for streamlined effects in either aircraft or watercraft. In order to make the details clearer, most of the layers or parts are slightly separated in this and succeeding sketches.

The upper cross section, Fig. 3, illustrates one of the earliest applications of flexible-bag molding to plywood. The convex mold *C* may be of metal (with or without heat), of wood or of concrete. The veneer layers, of which three are shown, are successively laid (technically wrapped on) against the mold with adhesive between each layer. The outer and inner layers may be lengthwise of the mold, or at an angle of 60 or 45° thereto. The center layer, like a half-hoop, may be crosswise, or at a considerable angle to the adjacent veneers. These layers are temporarily fastened in place by tacks, tape or staples until the adhesive bond is cured. An inflatable rubber mattress, *A*, is laid over the outer veneer, and above this a sturdy semicylindrical steel shell, *B*, is placed which is firmly bolted to the base, *E*. This rubber mattress, or closed bag, is flexible rather than extensible. It is inflated through *D* with steam, hot water or compressed air, or a combination of these fluid-pressure mediums. The fluid pressure forces the veneer layers together and against the mold at every point and holds them in that position until the adhesive bond is completed. It is necessary that the veneer strips be properly tapered before assembly so that all ends and edges fit closely together.

The cross section at the lower left of Fig. 3 shows the equipment necessary to produce the same plywood shape when using an autoclave or cooker, comprising a large cylindrical tank, with an end door that can be sealed tightly. Here a convex mold *F* (similar to *C*), with the wrapped layers of veneer temporarily fastened in place, is placed inside the open-mouthed rubber bag *G*, whereas in the first instance the mold and plywood were outside the bag. Any air within the bag, either initially there or caused by subsequent leakage, is exhausted through the vent *H*. The mold *F* and its enveloping bag *G* on the transfer car *K* is placed in the autoclave *T*, continuing the vacuum or vent connection *H* to the outside of the autoclave. Steam, hot water or compressed air is utilized



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LEGEND

Upper: inflated bag on solid mold
A—Inflated rubber mattress
B—Half steel shell to restrain mattress
C—Solid mold, wood or metal
D—Fluid-pressure inlet to inflate mattress
E—Base plate, to which B is bolted

Lower left: deflated bag on solid mold in autoclave
F—Solid mold, wood or concrete
G—Deflated rubber bag
H—Vacuum or vent connection
J —Fluid inlet, to produce pressure in autoclave
K—Transfer car T—Autoclave

Lower right: deflated half-bag on shell mold in autoclave
L —Shell mold of metal
M—Half-bag to be deflated
N —Cross frames to keep mold L rigid
P —Vacuum or vent connection
Q —Fluid inlet to produce pressure in autoclave
R —Transfer car S—Autoclave

3—*Methods of applying omnidirectional pressure. Parts are separated to show detail more clearly*

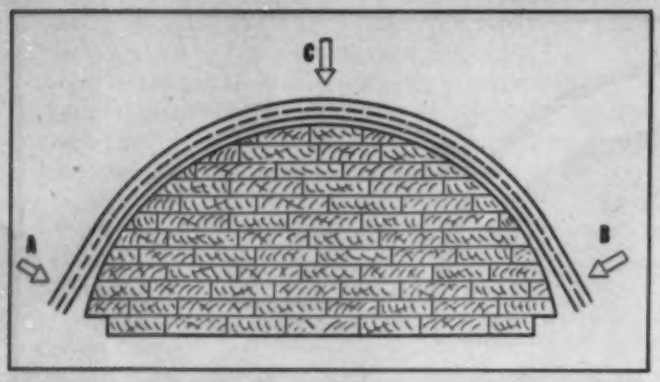
to produce fluid pressure inside the autoclave and against the rubber. This applies omnidirectional pressure of equal intensity over the entire curved-plywood surface. Care must be exercised to avoid any air pockets in the vacuum area, which often requires grooves in the mold, or perforated noncollapsible tubes to ventilate otherwise inaccessible spots. A ventilating pad should be located at the vent connection to prevent premature sealing at this point.

There is little difference between these two pressure-application methods, as the intensity of pressure may be regulated equally well in either. In both cases the pressure is applied on the outside or convex side of the curved plywood. However, the amount of vacuum pressure is additional to the positive pressure above atmosphere. The autoclave equipment with transfer car results in somewhat more convenient operations.

The third method, shown in the lower-right cross section of Fig. 3, requires a thin metal mold *L*, the contour of which is braced by frequent cross frames *N*, which in turn are bolted to the platform of the transfer car *R*. In this case the required amount of rubber *M* is reduced to approximately one-half, since the airtight metal sheet *L* serves as the other half of the vacuum enclosure. This single layer of rubber *M*, in the form of a blanket, is folded over and tightly clamped, at all ends and edges, to the thin metal face *L* of the mold. The vacuum connection *P* functions as has just been described, and air pockets must be similarly avoided.

A variant in this third method, not illustrated, is a plywood mold, $^1/_2$ to 1 in. thick, which serves similarly as half of the bag. Heat penetration through this moderately thin wood is slower than through thin metal, but far more rapid than in the case of solid-wood molds.

In contrasting this third method with the two preceding ones, it is to be noted that the mold is concave rather than convex, thus giving the outer or convex side of the cured plywood a smooth streamlined surface, which is a distinct advantage in either aircraft or watercraft. It is also evident that the heat of the autoclave fluid medium is applied to both sides of the plywood, i.e., through the rubber and through the thin metal.



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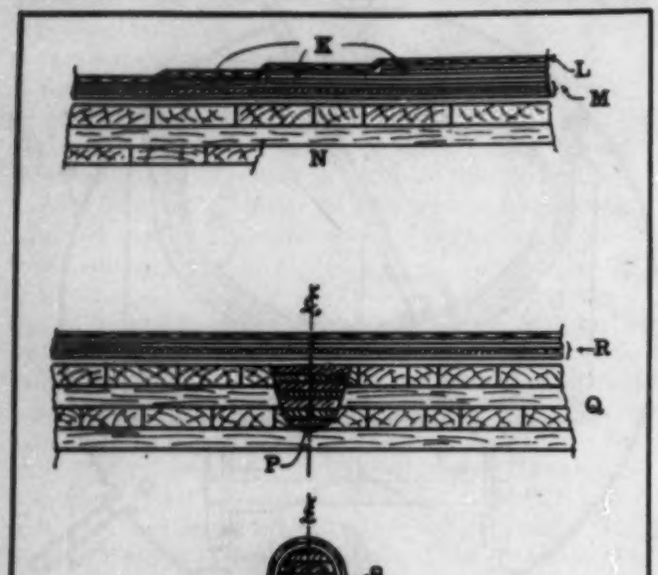

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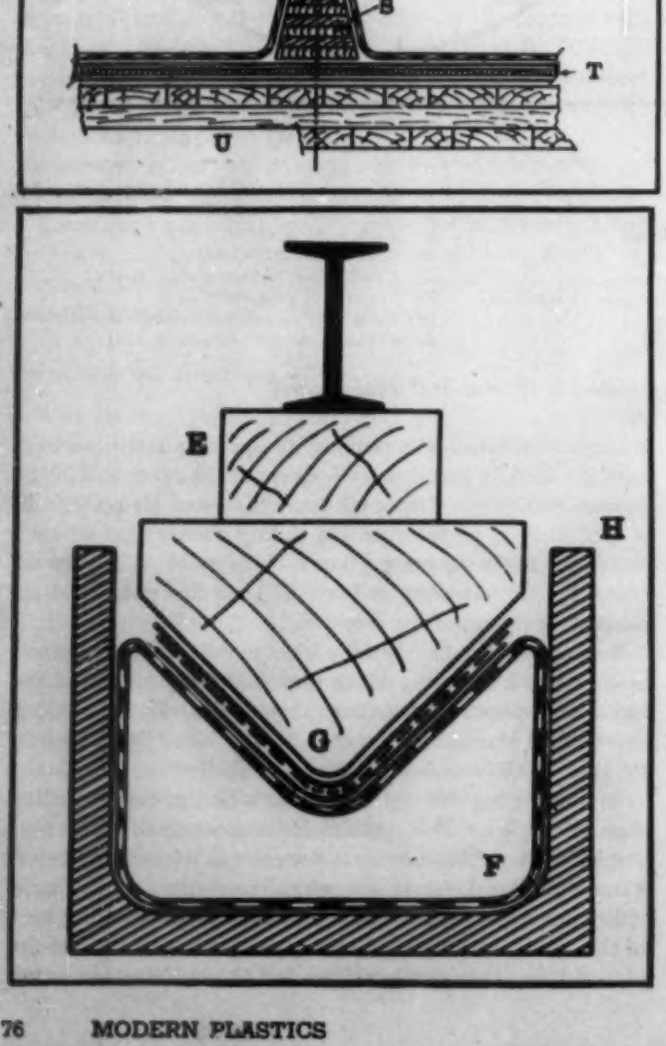

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This permits shorter curing cycles for the adhesive, since there is not only the double application of heat, but also there is no heavy thick mold to retard the rapid penetration of heat into the plywood.

Veneer versus two-ply layers in molding

While the larger proportion of molded plywood is made directly from single layers of veneer, there are instances where better results can be obtained from thin 2-ply layers, bonded together flat. Constructions where single layers tend to split easily are examples. Another case is a boat hull, to be made by any of the methods shown in Fig. 3. Here a large sheet of 2-ply layers can be used which will obviate the necessity of handling and fastening many narrow pieces of single ply. Deep gores or vees are cut in the ends of these large sheets of 2-ply layers, so that the edges of the cutouts fit accurately when laid over the mold. Two or three sheets of 2-ply layers are used, and the cutouts staggered for strength.

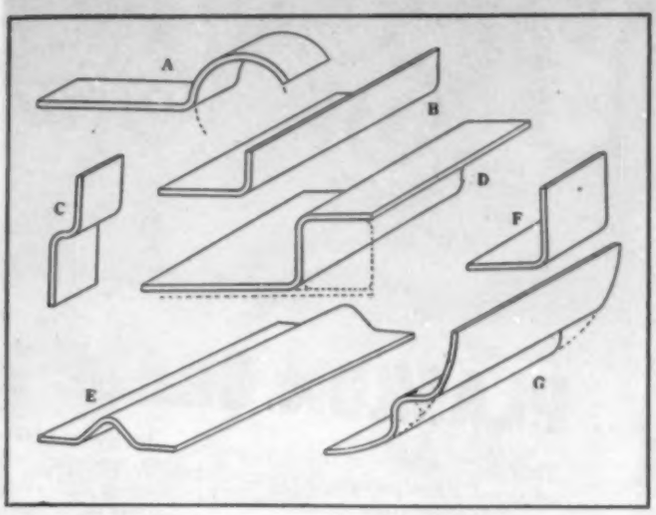
Effective versus ineffective pressure

One factor, which must be given due consideration in any of these fluid-pressure applications, is the inherent resistance of the wood layers to bending, twisting or curving. It is a general rule of plywood molding that the radius of curvature should not be less than approximately 75 times the thickness of the individual layers of veneer, hence the veneer thickness becomes an important design factor. A simple illustration of this resistance of wood to bending into curves is shown in Fig. 4. In this case, with a known total pressure at *C*, such as 60 p.s.i., an appreciable portion of this pressure may be neutralized by the stiffness of the wood, or its natural resistance to bending, as at *A* and *B*. Assuming that it requires 10 lb. of pressure to hold the veneer layers snugly against the mold at *A* and *B*, then $^1/_6$ of the total pressure at *C* is ineffective when applied at *A* and *B*, leaving 50 lb. of "net effective" pressure at the ends of the veneer layers. While this example is a relatively simple one, there are numerous more complex situations where the ratio of ineffective pressure to net effective pressure may be distinctly greater. Adequate allowances must always be made for this factor of ineffective pressure in forcing flat wood sheets or strips into curved layers.

Variable thicknesses

It was pointed out earlier in this paper that flexibly molded plywood can be made in assemblies of varying thicknesses and bonded together in one operation. Several examples are shown in Fig. 5. The upper sketch shows the overlaying of extra layers of veneer, which may be done on the bag side of the plywood as shown, or on the mold side by providing suitable recesses therein. This might occur where reinforcement is needed, as at the edge of a handhole, a door frame or where extra strength is needed inside the leading edge of the wing near the fuselage. The center sketch, Fig. 5, shows a ring or aileron prelaminated from parallel layers to the proper shape

***4**—Effective pressure in flexible-bag-molding. The ineffective pressure at A and B, neutralized by bending of veneer layers, must be deducted from total pressure at C to get net effective pressure.* **5**—*Variable thickness in molded plywood: a, overlayers of veneer for reinforcing; b, stiffening rings of laminated wood recessed in mold; c, stiffening rings on bag side of plywood.* **6**—*Method of molding angle clips with flexible tubing: E, spacer block; F, rubber hose; G, wood mold; and H, steel channel*



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and recessed in the mold. Accurate dimensioning is imperative to keep the gluable surface of the ring exactly flush with the mold. If it is less than flush, the joint will be poor, and if it is too high, a ridge will show on the outside of the plywood. A more efficient method of attaching the rings or ailerons is shown in the lower sketch of Fig. 5, where the additional member is on the bag side rather than recessed in the mold. These variable-thickness constructions can be adapted to the three major types of technique previously outlined in Fig. 3.

Supplementary methods of applying fluid pressure

In addition to the basic methods described, there are several more important supplementary processes that are typical of many other adaptations.

One of the simplest applications of fluid pressure is that shown in Fig. 6, where the flexible bag is a tube or a section of inflatable hose *F* and is laid in a rigid channel iron *H*. This channel iron takes the place of the semicylindrical shell *B*, in the upper sketch of Fig. 3, and restrains any effective pressure except upward. The layers of veneer are forced against the wood mold *G* (Fig. 6) by inflating the hose *F*. This fluid pressure may be steam or hot water and should circulate through the hose to maintain uniform temperature, since the heat losses against the channel on three sides may be considerable. Either 2-ply or 3-ply resin-bonded plywood can be used instead of single-ply veneer, but such multiple products would require steaming, prebending and drying before assembly. This plywood angle clip is one of many types used for stiffeners, attachments, seat anchors and the like in many types of plywood planes and gliders. A number of other similar shapes are shown in Fig. 7, all of which can be made by this process. Such shapes can also be formed between pairs of heated metal dies, if the quantity is sufficient to justify the cost of the necessary equipment.

A different application of flexible tubular pressure can be made for secondary- or assembly-gluing, as is shown in Fig. 8, which is in contrast with primary-gluing in the original flat or curved plywood. In this case, the problem is one of bonding a thin-plywood skin covering to a series of curved ribs or stiffeners. A small cross section of one of the two-piece hinged clamps is shown in the lower part of Fig. 8, while a more detailed longitudinal section of a single joint is outlined in the upper part. The requirements of pressure are that it must be applied over a narrow area, but continuously around the entire periphery of the wing. Nailing strips, clamp pressure or dead-loading have all proved unsatisfactory. Nailing strips vary in intensity; nailing strips and clamp pressure have no "follow-up" and will gradually reduce; and dead pressure with weights or loadings is only effective in a vertical direction.

The fluid medium in such tubular-pressure applications is usually compressed air, since heat losses from the use of steam or hot water in such a small hose might be excessive. The thin-metal strap *D*, Fig. 8, is used to distribute the pressure and to prevent the sagging of the skin covering between the ribs. A strip heater of the resistance type *C* supplies the required heat to cure the resin bond in the joint. The inflatable hose *B*, should be wholly deflated in the closed clamp so that the area of tubular-pressure contact may be adequate. Only enough space should be allowed between the clamp member *A* and the plywood skin to provide for the insertion of the equipment indicated. The pressure to be applied will depend upon the stiffness of the ribs, but it should be as great as possible without damaging deflection on these supporting sections. Such assembly joints without tubular pressure have necessarily been made with a cold-setting urea-formaldehyde resin adhesive, and the clamping time was a matter of hours. With tubular pressure, it can be reduced to twenty or thirty minutes with the proper type of strip heater.[14]

Another application of an inside flexible bag is shown in Fig. 9 where a complete plywood aileron can be molded against a pair of convex matrices. It is to be noted that this provides an outer streamlined surface, and that overlays of veneer may be used to provide a thicker section at the inside of the leading edge, as is shown in the upper (*Please turn to page 130*)

***7**—Molded- or formed-plywood clips. A, flat plywood to metal tubing; B-F, angle clip; C-D, offset clip; E, stiffener; G, cylindrical surface to metal rod.* ***8**—Tubular pressure in assembly-gluing. A, upper half of two-piece clamp; B, deflated hose; C, strip heater, resistance type; D, metal strap to equalize pressure; and E, a smaller cross section of complete 2-piece clamp for assembly gluing*

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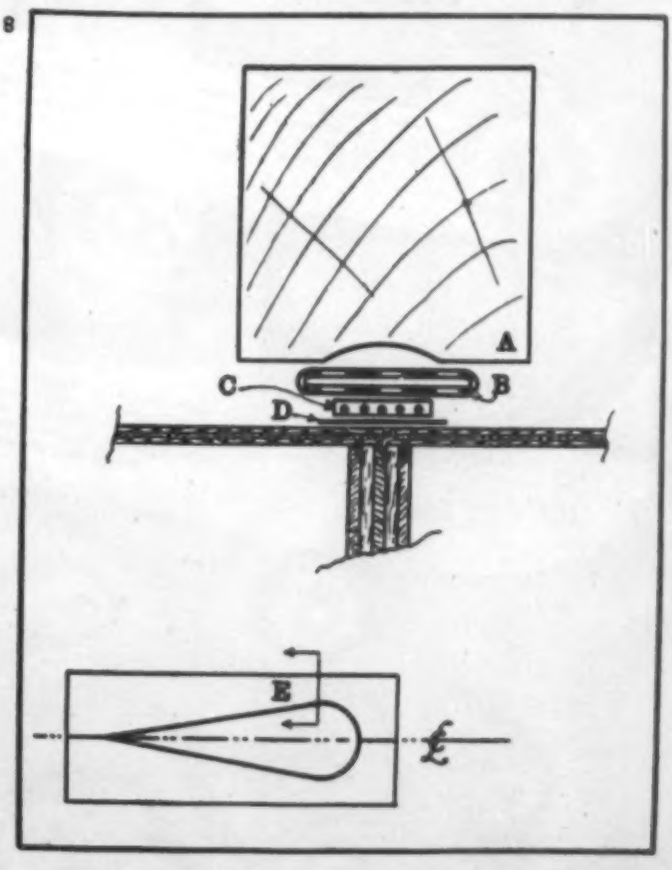

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Plaskon Molding Material is a thermo-setting urea-formaldehyde compound. The combination of properties listed below indicates the extremely versatile nature of Plaskon, and accounts for the many million pounds used annually for an infinite variety of products from buttons and cosmetic closures to large weighing scale housings and illuminating reflectors.

1. Wide Range of Standard Shades. Lightfast hues from translucent natural and pure white to jet black.
2. Attractive Surface. Smooth, eye-catching, warm to touch.
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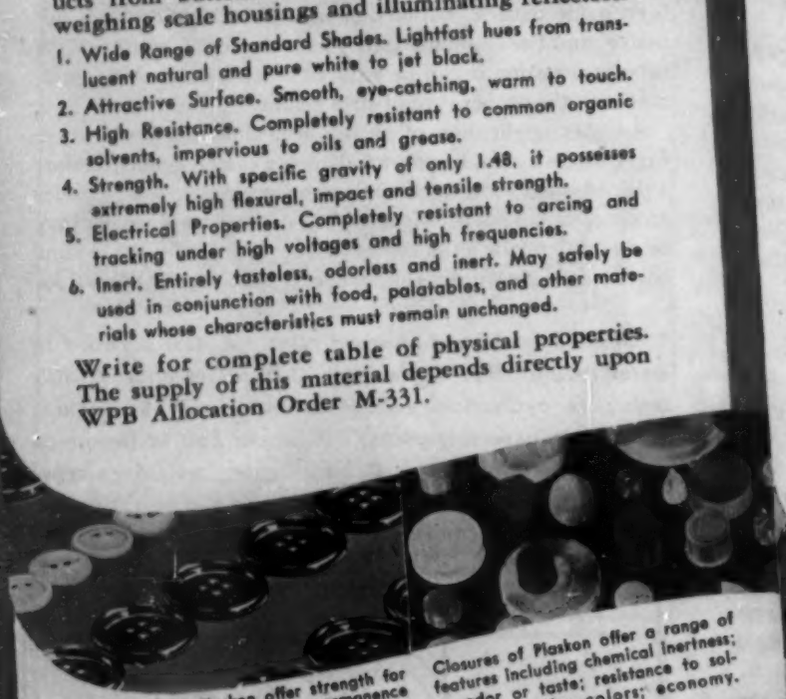
5. Electrical Properties. Completely resistant to arcing and tracking under high voltages and high frequencies.
6. Inert. Entirely tasteless, odorless and inert. May safely be used in conjunction with food, palatables, and other materials whose characteristics must remain unchanged.

Write for complete table of physical properties. The supply of this material depends directly upon WPB Allocation Order M-331.



Buttons of Plaskon offer strength for service; correct colors; permanence in laundering; smoothness; uniform shades and textures; speedy sewing on; economy of cost.

Closures of Plaskon offer a range of features including chemical inertness; no odor or taste; resistance to solvents; attractive colors; economy.

Reflectors of Plaskon offer many features including extreme safety, great strength, low heat transference, light weight, and correct shades for lighting efficiency.

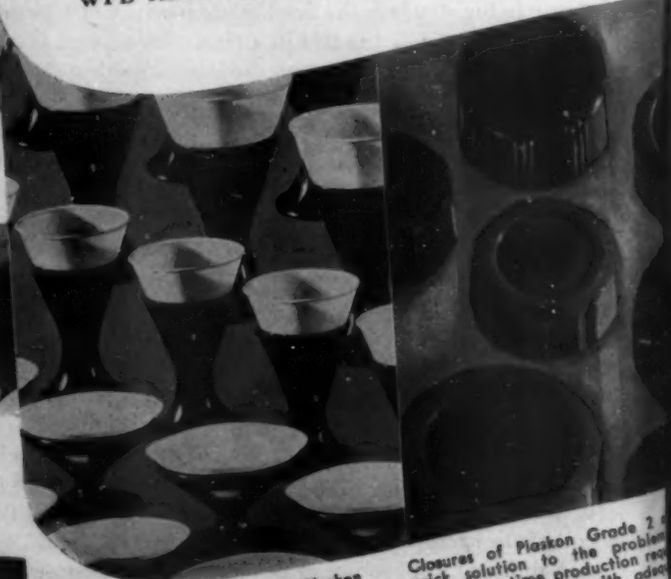
These spools of Plaskon, for special photographic war film purposes, are rust- and corrosion-free, non-detectable because non-metallic, light in weight and strong.

PLASKON GRADE 2

This is a thermo-setting urea-formaldehyde plastic of good Plaskon quality, developed to satisfactorily meet demands for economical production of a wide range of molded parts. These are some of its features:

1. Non-Bleeding in Alcohol and Other Common Solvents. Plaskon Grade 2 is highly adaptable for closures on containers for a wide range of drugs, cosmetics, liquors, and similar products.
2. Good Resistance to Water and Laundering Compounds. Grade 2 Plaskon is ideal for the production of an endless variety of buttons and similar items of utility. Will not lose lustre, surface, or color in laundering.
3. Electrically Non-Tracking. Grade 2 Plaskon assures the same freedom from arcing and tracking as regular Plaskon, under high electrical stress. It has the identical unusual dielectric strength of regular Plaskon.
   Furnished in one shade of black and brown only.

Write for complete table of physical properties. The supply of this material depends directly upon WPB Allocation Order M-331.



These soda cup holders of Plaskon Grade 2 are non-shattering, durable, easy to wash, maintain high sanitary standards, attractive, inert, and economical.

Closures of Plaskon Grade 2 a quick solution to the problem meeting wartime production req ments at low cost, with adeq safety for your product.

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PLASKON MELAMINE

This thermo-setting material is similar to Plaskon urea-formaldehyde in many ways, but offers additional features for the molding of products requiring these special characteristics:

1. Very Low Moisture Absorption. Assures ample protection where the presence of water or high humidity prevents the use of urea compounds.
2. Exceptional Resistance to Acids and Alkalies. Molded Plaskon Melamine is non-porous and non-corrodible.
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4. Extreme Heat Resistance. Plaskon Melamine offers the highest heat resistance of all light-colored plastics.

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These Silex top bowls, neck rings and handles are made of Plaskon Melamine Compound because of its strength, light weight, sanitary features, absence of water absorption, and economy.

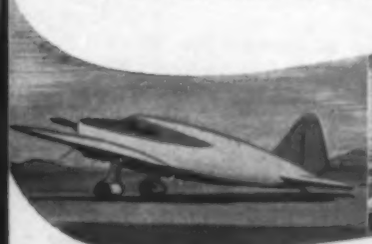
Plaskon Melamine dishes weigh 70% less than crockery, and effect a 30% saving in shipping space. Completely resistant to staining by foods and liquids.

PLASKON GLUE

Plaskon Resin Glue is applicable to all types of jobs for which glue always has been used. In addition, it is opening up new fields of manufacture, permitting the development of products offering unusual efficiencies and services. Highly adaptable to the veneering, laminating and bonding of paper, wood and fabric products. Assures a permanent, waterproof, unbreakable bond.

1. Great Strength. Materials bonded by Plaskon Resin Glue cannot be separated at the glue line—the material fails first.
2. Waterproofness. The Plaskon glue line is completely moisture-resistant, cannot be attacked by bacteria or weakened by mold or fungi.
3. Permanence. Maintains its tenacious grip in heavy-duty service for years, under water, on land, in the air.

Write for complete table of physical properties. The supply of this material depends directly upon WPB Allocation Order M-331.



The permanence and safety of Plaskon Resin Glue have stimulated the production of aircraft of plywood and assembled wood parts, in large quantities, to meet war emergencies.

Plaskon Resin Glue makes possible the construction of light, tremendously strong plywood treadways and pontoon bridges. The wood remains tough, resilient and fire-resistant indefinitely.

Beautiful decorating effects are achieved with plywood panels made with Plaskon Resin Glue. Quick, economical construction is possible with these panels.

Boxboard made with Plaskon Resin Glue is used for V-Containers, filled with food and supplies and then dumped into the ocean to be washed ashore by waves and tides.

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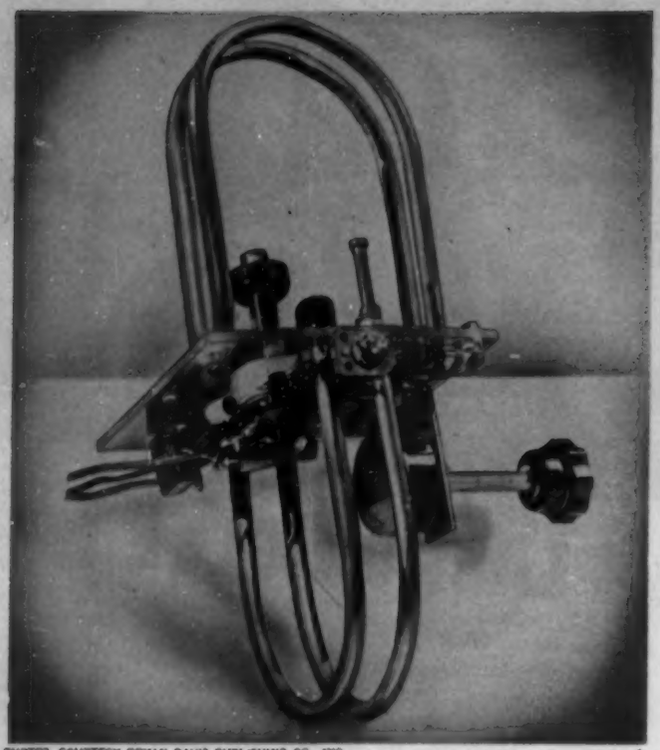

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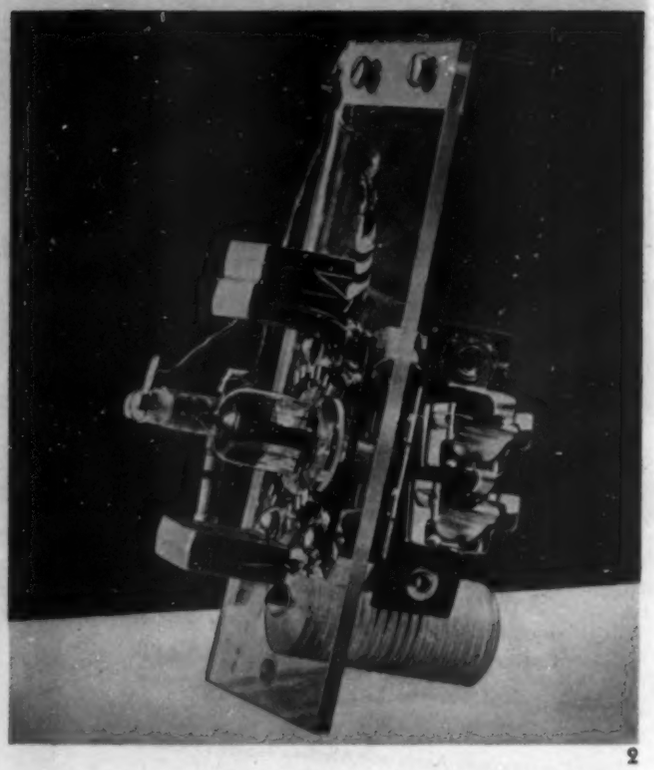


2

1—The volume control on the right of this detector unit is used to vary the value of the grid resistor. The coil mounted on polystyrene rod to the rear of the tube is movable, varying the coupling of the quench oscillator coil. The capacitive coupling between the grid and plate at resonant frequency is varied by the adjustable screw to right of the tube. 2—All components of this r-f unit with the exception of the plate loop are mounted on a polystyrene strip to facilitate comparison of various types of r-f stages

Polystyrene for wartime electronics

by F. E. Wiley*

IT is common knowledge that electronics has become a vital part of our war effort. Closely associated with the word "electronics" is the term "high frequency." The advent of high frequency has greatly changed the peacetime electronic industry, for in addition to the change evoked by the use of higher frequencies, a very great number of radio and non-radio producers have added electronic divisions so that today we have a tremendous new field manned by new personnel who are demanding new materials.

The ideal electronic high-frequency insulating material of today should possess the following properties:

Low dielectric constant
Low power factor
No change in dielectric constant or power factor from very low to very high temperatures
No change in dielectric constant or power factor from low to very high frequencies
Zero water absorption
Very high voltage breakdown
A material non-tracking on puncture
Dimensional stability
Freedom from "creep"
Ease of bending, punching, molding and machining
Mechanical properties sufficient to withstand a designated load under shock or vibration
Availability in sufficient quantity, with a uniform quality at a reasonable price.

A review of the above listed requirements has led some engineers to believe that no such material exists, and that materials should be selected on the basis of the relative importance to a specific application of the twelve requirements. Adopting this sound approach to the problem, it has been found that polystyrene, a synthetic resin, comes very close to satisfying all twelve requirements. Manufacturers to whom polystyrene is a new material are surprised to learn that styrene was first produced in 1831, and was first polymerized in 1839. This is not strange, however, for extensive commercial production did not start until 1937, almost 100 years later, largely due to the low demand for the material because its quality was poor and its electrical properties not generally recognized.

In view of this history, it is little wonder that some engineers, unfamiliar with polystyrene, continue to reject it either on its reputation or because of the disastrous results of early trial applications. Within the last two years, many successful applications of polystyrene have been made in the electronics industry, and many improvements in quality

* Plax Corporation.

and fabrication methods have been worked out in the industrial laboratories.[10] It is thought that a discussion of the present status of polystyrene will aid those who are relatively unfamiliar with this material in applying it to war uses.

The early form of polystyrene was often rejected by industry because its initially transparent surface tended gradually to assume a white, frosted appearance on aging. It was discovered that this frost was composed of minute cracks in the surface and was caused by volatile impurities and residual monomeric styrene. The current commercial methods of producing polystyrene molding compound have eliminated this type of defect, however, and those who have rejected polystyrene in the past are encouraged to examine articles produced from the newer molding compound.

Another serious cause of service failure was the molding technique used. Polystyrene is a resin possessing long molecules capable of being highly oriented. Strength properties of oriented polystyrene are improved in the direction of orientation, but lowered in the direction perpendicular to the orientation. Such orientation is caused by rapidly flowing the plastic at a relatively low molding temperature into position under high pressures, then cooling the molded shape immediately. Orientation occurs in the direction of flow and therefore weakness appears along the lines of flow. Many articles molded in such a manner have failed early in service and are not generally considered commercially satisfactory. Recently, experienced plastics molders have reduced this danger of failure by (*Please turn to page 134*)

TABLE I.—PROPERTIES OF POLYSTYRENE[1-9]

MECHANICAL		
Tensile strength, p.s.i. (A.S.T.M. D 48-37)		5500–7000
Tensile proportional limit, p.s.i. (.01% offset), −38° F.		3700
Tensile proportional limit, p.s.i. (.01% offset), 0° F.		2800
Tensile proportional limit, p.s.i. (.01% offset), 78° F.		2500
Modulus of elasticity in tension, p.s.i., −38° F.		554,000
Modulus of elasticity in tension, p.s.i., 0° F.		536,000
Modulus of elasticity in tension, p.s.i., 78° F.		469,000
Modulus of elasticity in compression, 78° F., p.s.i.		560,000
Compressive proportional limit, p.s.i. (.01% offset)		2600
Compressive strength, p.s.i.		15,200
Rockwell hardness (1/2-in. ball, 60-kg. load)		R90–R97
For design purposes, a maximum normal stress of 750 p.s.i. is safe, and a stress of 1200 p.s.i. should not be exceeded.		
ELECTRICAL		
Volume resistivity, ohm-cm.		10^{17}
Arc resistance (A.S.T.M. D495-38T), sec.		240–250
Dielectric strength, volts per mil, .005 in. thickness		3500
Dielectric strength, volts per mil, .010 in. thickness		2500
Dielectric strength, volts per mil, .015 in. thickness		2200
Dielectric strength, volts per mil, .125 in. thickness		500–700
Frequency	*Dielectric constant*	*Power factor*
60 cycles	2.5–2.6	.0001–.0002
10^3 cycles	2.5–2.6	.0001–.0002
10^6 cycles	2.5–2.6	.0001–.0004
10^{10} cycles	2.5–2.6	.0002–.0004
Corona voltage = 85,000		
Electrical properties are constant from very low temperatures up to about 75° C. (167° F.). At 90° C, power factor = .0009; dielectric constant = 2.6 at 60 cycles.		
THERMAL		
Distortion temperature (A.S.T.M. D48-37), ° F. (° C.)		176–194 (80–90)
Transition temp., ° F. (° C.)		180 (82)
Softening point, ° F. (° C.)		220–240 (104–116)
Ignition point, ° F. (° C.)		1350 (732)
Specific heat, cal. per gr. per ° C.		.32
Thermal expansion coefficient, per ° C.		7.2×10^{-5}
Thermal conductivity, cal. per sec. per cm. per ° C.		3.2×10^{-4}
Burning rate		Low
PHYSICAL		
Light transmission (.10 in. thick), %		90
Refractive index, n_D^{25}		1.59
Specific gravity		1.05
Specific volume, cu. in. per lb.		26.3
Water absorption in 48 hr.		.0000
Tendency to cold flow		Very slight
CHEMICAL		
Effect of:		
Weak and strong acids*		None
Weak and strong alkalis		None
Alcohols		None
Esters		Soluble
Oils		Soluble

* Strong oxidizers will discolor.

Properties of laminated phenolics

by L. E. CALDWELL*

As a result of shortages in the supply of critical materials, manufacturers are constantly seeking replacements, and often these replacements prove, through their performance, to be better suited for the job than the materials that they replace. One such material is an industrial phenolic laminate now being used in place of rubber, bronze, steel, tin, aluminum and other metals for bearings. In some of these applications, laminated plastics can be used with satisfactory results in exactly the same manner as the materials they replace. However, in other instances changes in design may be necessary to obtain the best performance because of the difference in physical properties.

The purpose of this article is to give the more important physical properties of laminated phenolics and, to a limited extent, to compare them with the corresponding properties of other materials.

The different grades of laminated phenolics have inherent characteristics which are imparted by the materials from which they are made. The quantity as well as the type both of resins and of fillers affects their physical properties to a marked extent. To meet the requirements of specific applications or fabricating methods several grades of laminated plastics have been developed, such as laminates filled with minerals, graphite or extra heavy weave fabrics for mill bearings; laminates with plasticized resins for good punching qualities; and laminates thoroughly impregnated with a high percentage of resin for purposes requiring low moisture absorption, etc.

Good electrical properties are produced at a sacrifice of good mechanical properties and vice versa. This is the result of the weakening of the base materials caused by the necessary purification of the cellulose in order that the best electrical characteristics may be obtained.

The cloth base grades of laminated phenolics usually have greater mechanical strengths than the nearest corresponding types of paper base grades, with the exception of tensile strengths. The paper base grades excel in electrical properties.

Laminated phenolics made with extra heavy weave cloth give the greatest impact strength. However, the other mechanical strengths of these grades are exceeded by the grades containing finer weave fabrics.

The mineral-filled grades offer the best wear resistance. Laminates filled with asbestos cloth or asbestos paper have the best heat resistance. For continuous operation the maximum recommended temperature for these grades is 125° C. The other grades may be operated at this temperature intermittently, but they should not be operated continuously at a temperature in excess of 100° C.

Application of directional loads

To better understand the physical properties of laminated plastics, the methods of loading to obtain the greatest strengths should be considered. In general, the strength of laminated plastics depends greatly upon the direction in which the load is applied and in order to obtain the best results, this should be considered in designing. Figure 1 should be used as a guide in applying loads. Principles involved in these examples are fundamental and apply to almost all types of loads.

As a key to the directional loads referred to in Fig. 1, these definitions should be considered:

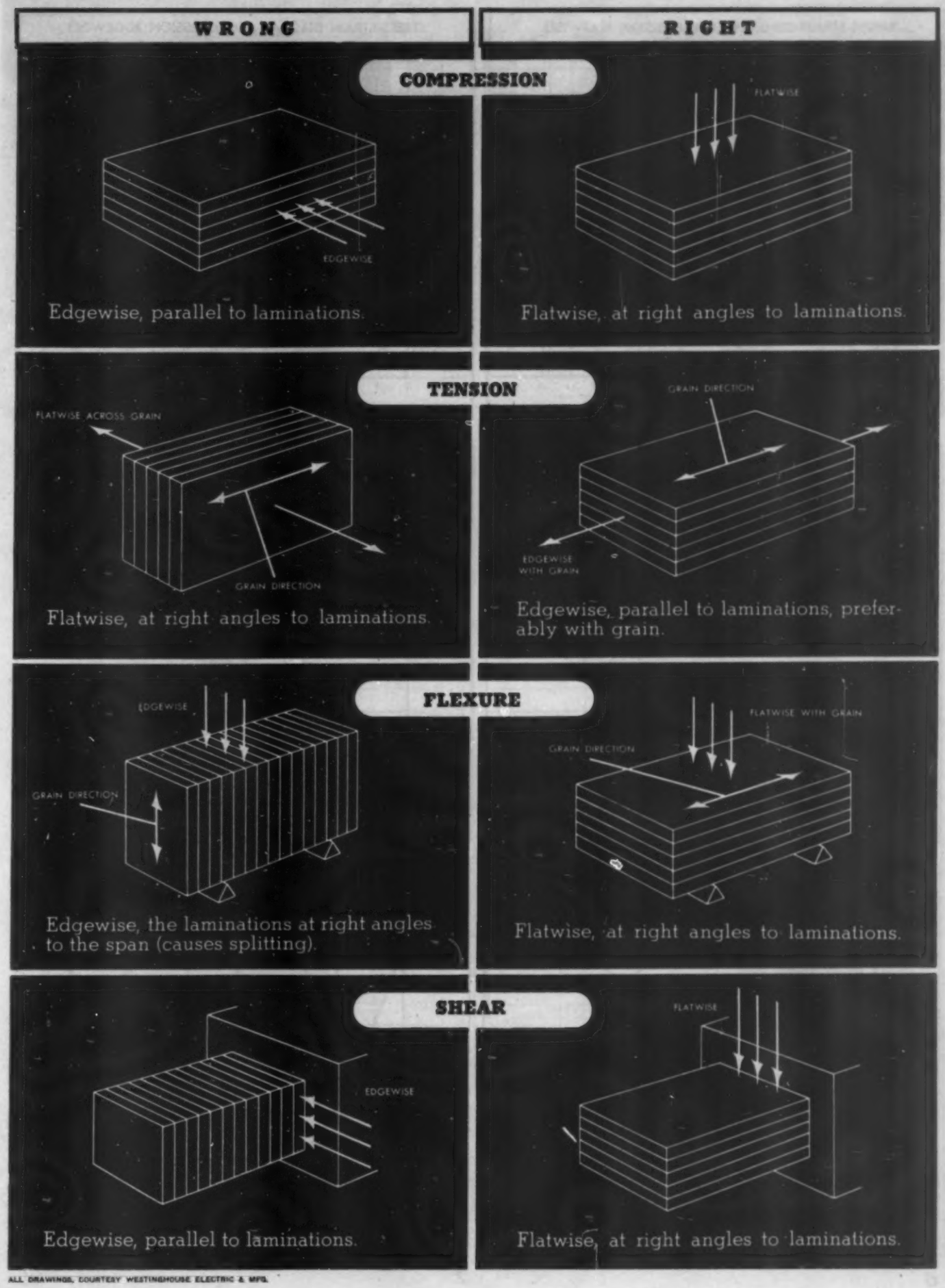
* Micarta Engineer, Westinghouse Elec. & Mfg. Co.

TABLE I.—PHYSICAL PROPERTIES OF PAPER LAMINATES, FABRIC LAMINATES, WOODS AND METALS

Material	*Specific gravity*	*Tensile strength, p.s.i.*	*Ratio of tensile strength to sp. gr., p.s.i.*	*Compressive strength, p.s.i.*	*Ratio of compressive strength to sp. gr., p.s.i.*	*Modulus of elasticity in tension (Et), p.s.i.*	*Ratio of Et to sp. gr., p.s.i.*	*Modulus of elasticity in compression (Ec), p.s.i.*	*Ratio of Ec to sp. gr., p.s.i.*
Laminates:									
Kraft paper	1.35	16,000	11,800	38,000	28,100	1.7×10^6	13×10^5	0.83×10^6	6.2×10^5
Absorbent paper	1.35	11,000	8,150	31,000	23,000	1.05×10^6	7.8×10^5	0.6×10^6	4.5×10^5
Fine weave fabric	1.35	12,500	9,250	35,000	25,900	1.0×10^6	7.5×10^5	0.61×10^6	4.5×10^5
Coarse weave fabric	1.38	11,000	8,000	35,000	25,400	1.05×10^6	7.6×10^5	0.56×10^6	4.1×10^5
Stainless steel (18-8)	7.85	185,000	23,600	150,000*	19,100	30×10^6	38×10^5	30×10^6	38×10^5
Chrome molybdenum steel (heat-treated)	7.85	180,000	22,900	150,000*	19,100	29×10^6	37×10^5	29×10^6	37×10^5
Aluminum alloy (24-St)	2.80	62,000	22,100	40,000*	14,300	10.4×10^6	37×10^5	10.4×10^6	37×10^5
Magnesium alloy (AM-585)	1.81	46,000	25,400	35,000**	19,300	6.5×10^6	36×10^5	6.5×10^6	36×10^5
Aircraft spruce (Douglas fir)	0.43	10,000	23,300	5,000	11,600	1.3×10^6	30×10^5	1.3×10^6	30×10^5
Birch plywood	0.80	13,100	16,400	5,700	7,100	1.4×10^6	18×10^5	.....	.....

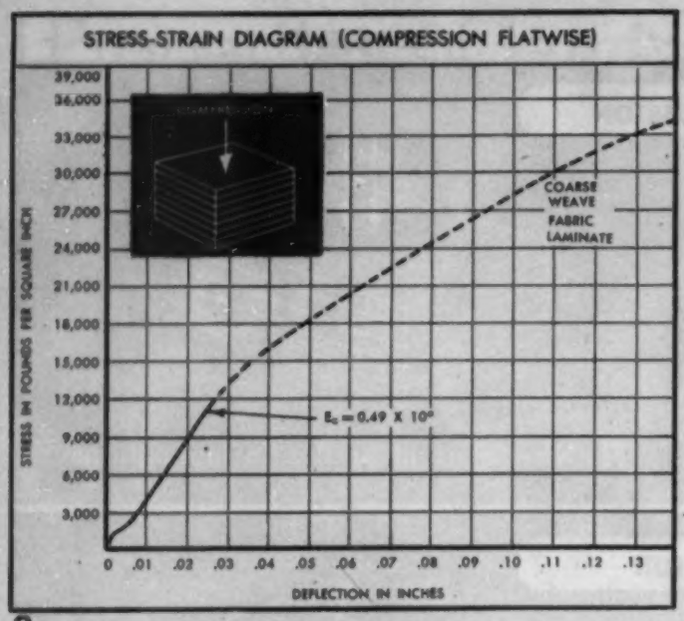
* Yield point in compression.

** Yield point in tension. Yield point in compression is substantially equal to yield point in tension in wrought alloys.



ALL DRAWINGS, COURTESY WESTINGHOUSE ELECTRIC & MFG.

1—*These diagrams illustrate the right and wrong methods for determining directional loads*



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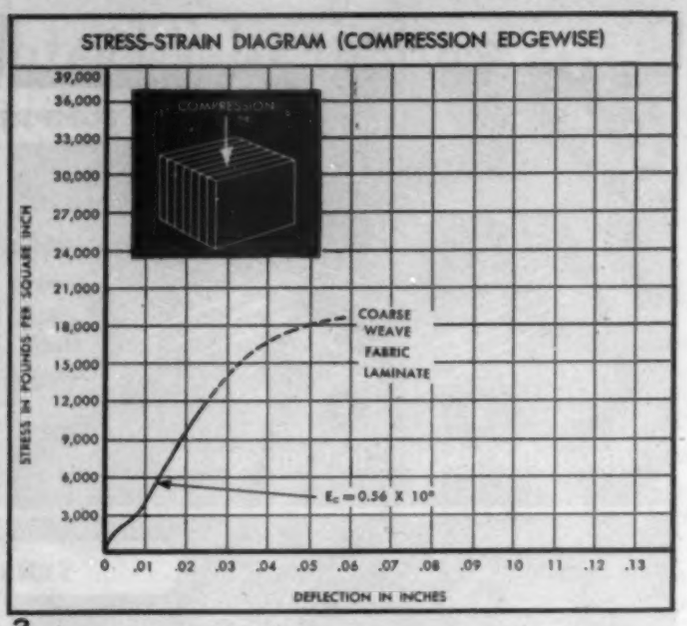

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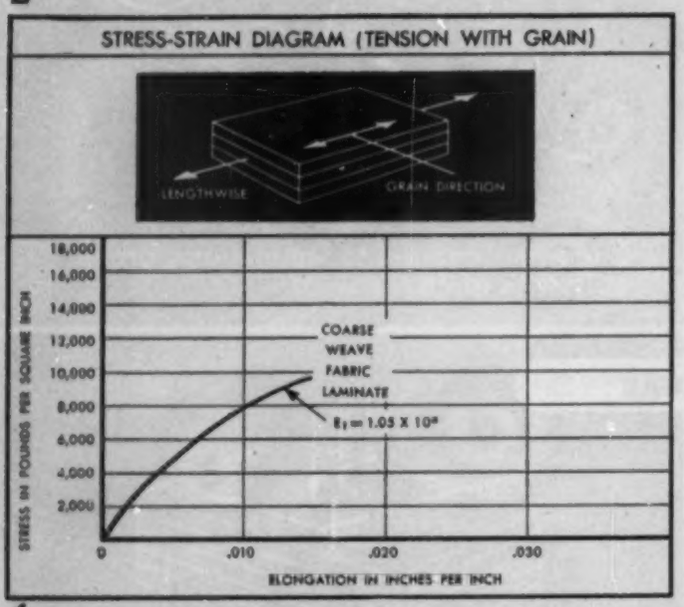

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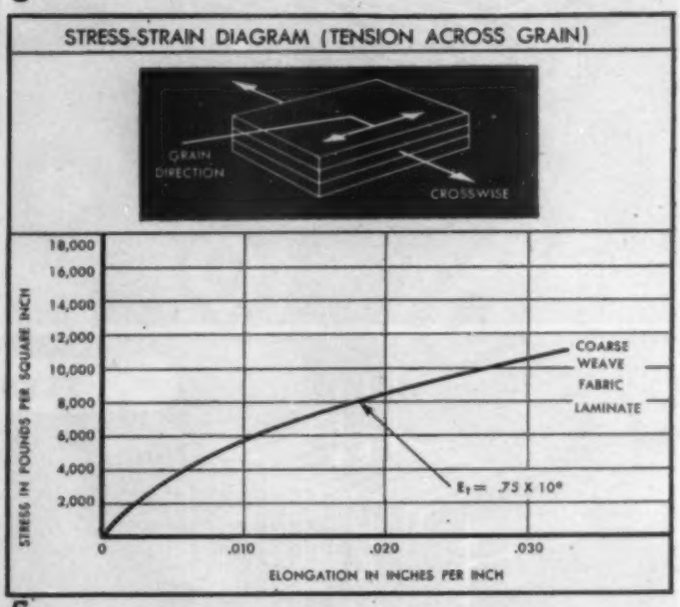

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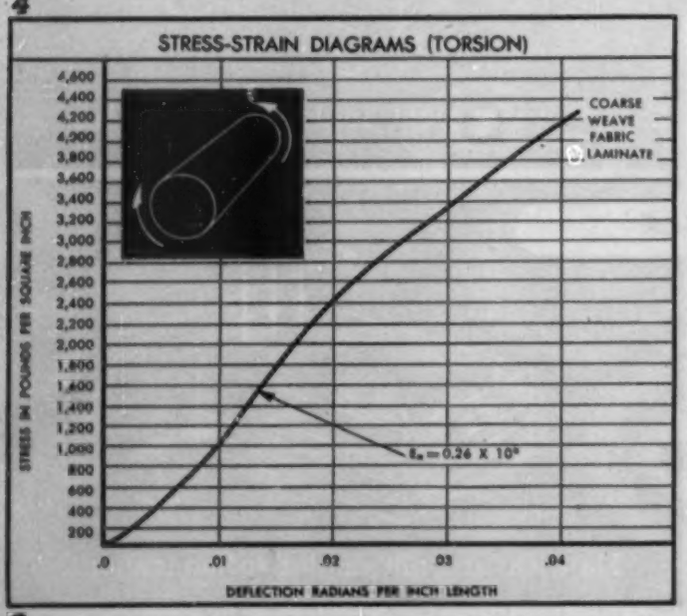

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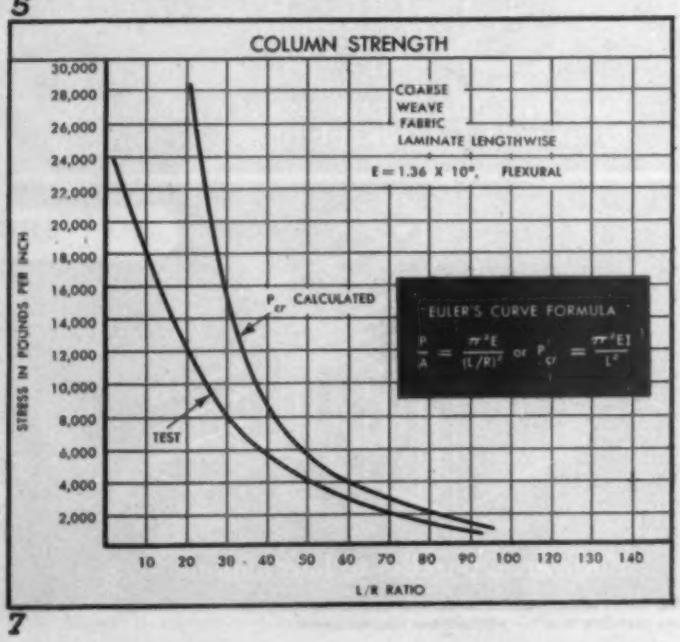

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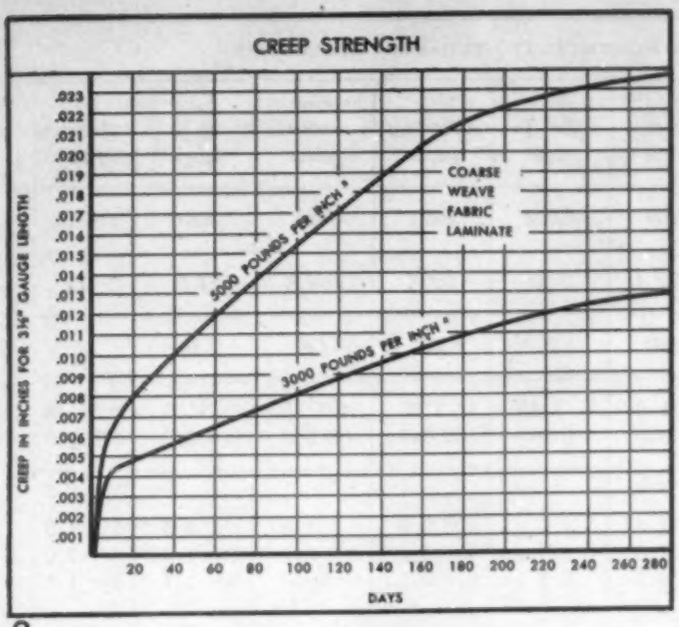
2–7—Characteristic curves for typical laminated phenolics. Test data for 2 to 7 were determined at room conditions



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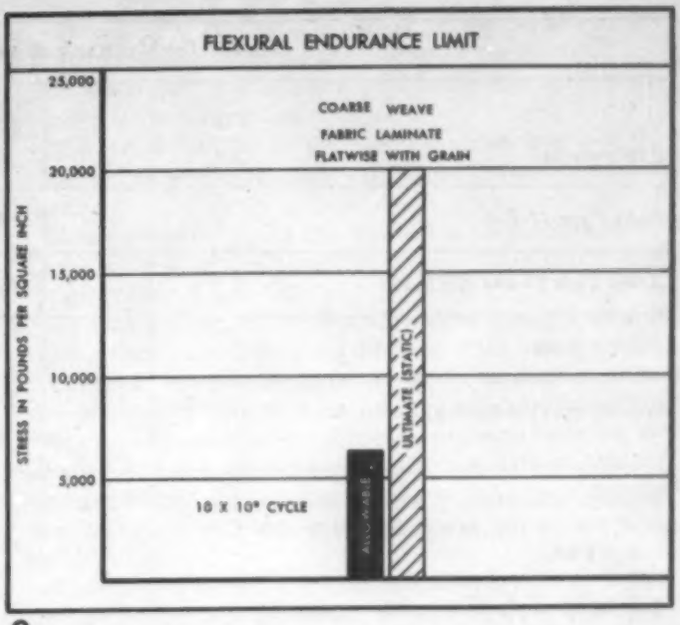

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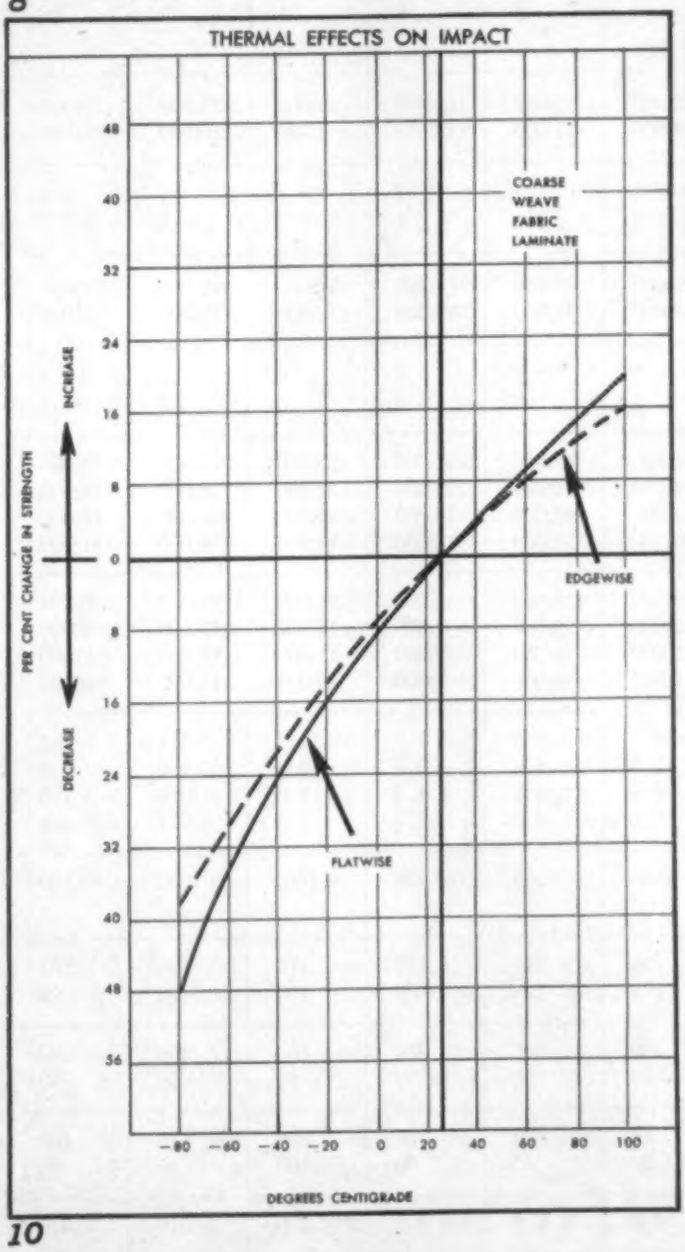

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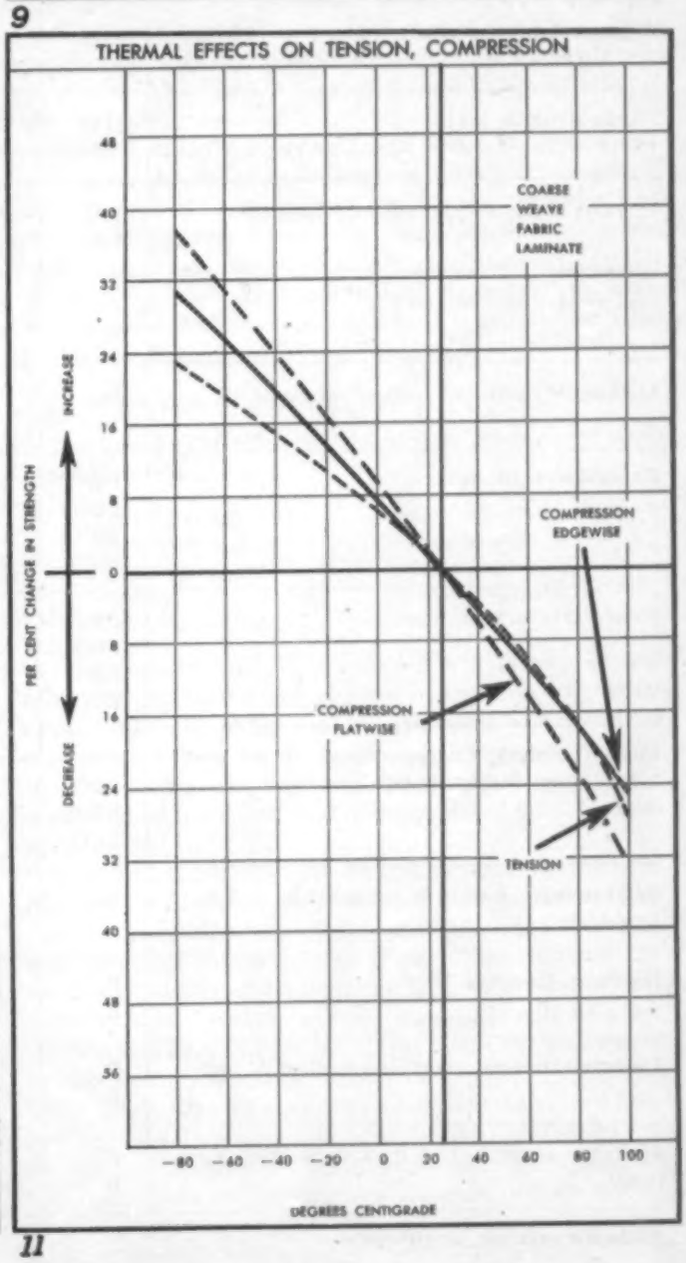

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8–11—*Data for* **8** *and* **9** *also were determined at room conditions;* **10** *and* **11** *show effect of temperature changes on strength*

TABLE II.—MECHANICAL AND ELECTRICAL PROPERTIES OF LAMINATES

Base material		*Asbestos fabric*	*Kraft paper*	*Absorbent paper*	*Fine weave fabric*	*Fine weave fabric*	*Absorbent paper*
Navy Type 17-P-5		*FBH*	*PBM*	*PBG*	*FBE*	*FBI*	*PBP*
Army Type 71-484 HHP-256		*IV-AA*	*I-X*	*I-XX*	*II-LE*	*II-L*	*IP*
NEMA grade		*AA*	*X*	*XX*	*LE*	*L*	*P*
Specific gravity density, lb./cu. in.		1.8 0.065	1.35 0.049	1.35 0.049	1.35 0.049	1.35 0.049	1.38 0.050
Moisture absorption, % increase in weight 1 in. × 3 in. × thk. as indicated 24 hr. 25° C.—A.S.T.M.	Thk. 1/16" 1/8" 1/4"	 1.5 1.0 0.5	 6.0 3.2 1.1	 2.0 1.3 0.5	 1.5 0.9 0.55	 2.5 1.7 1.1	 4.0 2.0 1.1
Moisture absorption at saturation, 1 in. × 3 in. × 1/16 in.	...	4	15	8	5	6	8
Tensile strength, p.s.i.	WG CG	12,000 11,000	16,000 11,000	11,000 8,000	13,000 9,500	14,500 10,000	8,000 6,000
Modulus of elasticity, tension C, times 10^6	WG CG	1.3 1.3	1.7 1.1	1 1	1 0.7	1 0.8	0.9 0.7
Compressive strength, p.s.i.	F E	49,000 21,000	38,000 21,000	31,000 18,000	38,000 22,000	40,000 22,000	22,000 8,000
Modulus of elasticity, compressive, times 10^5	F E	7 5	7 8	6 6	6 6	6 6	6 5
Flexural strength, p.s.i.	FWG FCG EWG ECG	25,000 24,000 24,000 24,000	27,000 20,000 27,000 20,000	17,000 18,000 14,000 15,000	20,000 19,000 21,000 18,000	21,000 19,000 21,000 18,000	13,000 11,000 13,000 11,000
Shear strength, p.s.i.	FWG FCG EWG ECG	12,000 12,000 12,000 12,000	9,000 9,500 9,000 9,000	7,000 7,000 7,000 7,000	11,000 11,000 11,000 10,000	11,500 11,500 12,000 11,000	6,000 7,000 7,000 8,000
Impact strength, Charpy-method; ft.-lb. per in.; unnotched specimen 1/2 in. thick	FWG FCG EWG ECG	12.3 11.5 9.8 8.5	8.9 4.8 6.6 4.5	4.5 3.4 4.5 3.5	10.4 9.8 8.6 7.8	15.4 10.9 10.3 9.1	7.2 6.5 7.5 6.4
Bond strength, load in lb., sample 1 in. × 1 in. × 1/2 in.	WG	1100	1000	950	1600	1600	1100
Hardness, Rockwell "M"	F E	106 102	114 108	112 106	113 106	106 99	104 98
Dielectric strength, short time method, V./mil.	F E	100 30	500 60	450 60	400 80	250 50	600 50
Dielectric strength, step by step method, V./mil.	F E	60 20	300 45	350 60	250 60	175 45	450 60
Dielectric constant, at 10^6 cycles		6.6	6.5	5.5	5.0	5.8	5.3
Power factor, percent at 10^6 cycles		30	7.0	4.5	4.5	7.8	6.0

TABLE II (*Continued*)

Asbestos paper	*Absorbent paper*	*Coarse weave fabric*	*White paper core*	*Medium weave fabric*
PBH	*PBE*	*FBM*	*NDP*	*FBG*
IV-A	*I-XXX*	*II-C*	*NDP*	*II-CE*
A	*XXX*	*C*	*NDP*	*CE*
1.8 0.065	1.35 0.049	1.38 0.050	1.38 0.050	1.35 0.049
1.5 1.0 0.5	1.2 0.9 0.5	4.5 2.5 1.2	3.0 2.0 1.0	1.8 1.3 0.7
4	6	7	9	6
13,000 10,000	13,500 10,500	10,000 11,000	13,000 9,000	13,000 12,000
1 0.8	1 1	1 0.8	1.8 1.6	1 1
41,000 10,000	36,000 21,000	40,000 23,000	43,000 22,000	40,000 20,000
6 5	7 6	5 5	18 24	6 6
25,000 18,000 23,000 17,000	15,000 12,500 16,000 12,500	20,000 20,000 20,000 21,000	11,200 10,600 16,800 12,100	21,000 20,000 21,000 20,000
7,500 6,400 9,700 7,900	6,000 7,500 7,500 8,500	11,000 12,000 11,000 11,000	8,000 8,400 9,300 8,600	10,000 10,000 10,000 10,000
5.5 4.2 3.5 3.1	3.3 4.1 3.5 4.8	15.8 15.5 12.0 11.7	4.9 3.1 2.5 2.0	13.2 16.0 10.0 11.5
900	950	1800	800	1700
110 101	111 105	102 97	118 108	108 101
100 30	700 60	150 50	640 55	325 50
60 20	450 60	125 25	370 50	225 45
6.1	5.5	5.8	6.6	5 3
12	3.5	6.6	4.5	5.0

Flatwise (F). The load is applied to the flat side of the plate, perpendicular to the laminations of the plastic.

Edgewise (E). The load is applied to the edge of the plate, parallel to the laminations.

With Grain (WG). In the direction of the length of the plate, i.e., parallel to the cloth warp or lengthwise of the paper fiber.

Across Grain (CG). In the direction at right angles to the length of the plate, i.e., parallel to the cloth fill or crosswise of the paper fiber.

As defined above, the term "grain" is not synonymous with "laminations," but is the grain direction of the base material.

Compressive loads should be applied in the flatwise direction in order to take advantage of the greater compressive strength in this direction. However, edgewise loads are allowable; and in some instances where other factors must be considered they may be desirable, as in the case of certain marine bearings in which edgewise wear is more even than flatwise wear.

Tensile loads should be applied edgewise, preferably in the grain direction, since the tensile strength in this direction is usually somewhat greater than it is across the grain. Flatwise tensile loads should be avoided, since the flatwise tensile strength is relatively low because of the lack of continuity of the filler in this direction.

Flexural, shear and impact loads should be applied flatwise, preferably in the grain direction. However, these loads may be applied in the flatwise across grain, edgewise with grain, and edgewise across grain directions, since the corresponding strengths are sufficiently high to allow considerable loads. These loads should not be applied parallel to the laminations since the corresponding strengths are relatively low in this direction.

Tests of physical properties

The following significant physical tests are made on laminated phenolics:

Tensile strength	Compressive strength
Flexural strength	Shear strength
Impact strength	Bond strength
Hardness	Dielectric strength
Dielectric constant	Power factor

These tests are made by standard A.S.T.M. methods, and the results are determined at room temperature on samples as received. Strength values are calculated on the original dimensions of the test piece in all cases. When tests are made on a universal testing machine, the crosshead speed of the machine is adjusted so that it does not exceed 0.050 in./min. when running idle.

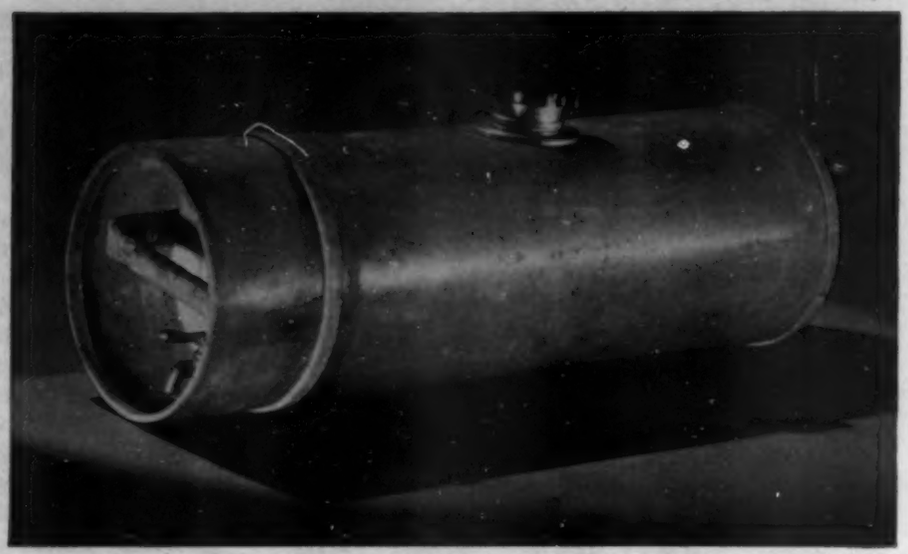
Other special tests are made on various grades of laminated phenolics to determine their suitability for special applications. Among these are coefficient of friction of bearings, wear resistance of bearings and doctor blades, moisture absorption of assembled bearings and flexural endurance limit of leaf springs. Usually such tests are made only on a few grades which have characteristics that render them especially suitable for the application in mind.

The data in the accompanying curves and tables give a composite picture of the mechanical and electrical possibilities and limitations of laminated. These are average values based on tests. All values are for plate only and since they are typical averages, variations of as much as plus or minus 10 percent may be expected.

Other forms—namely, angles, channels, zees, rods and tubes—may show variations depending (*Please turn to page 138*)

Life On The

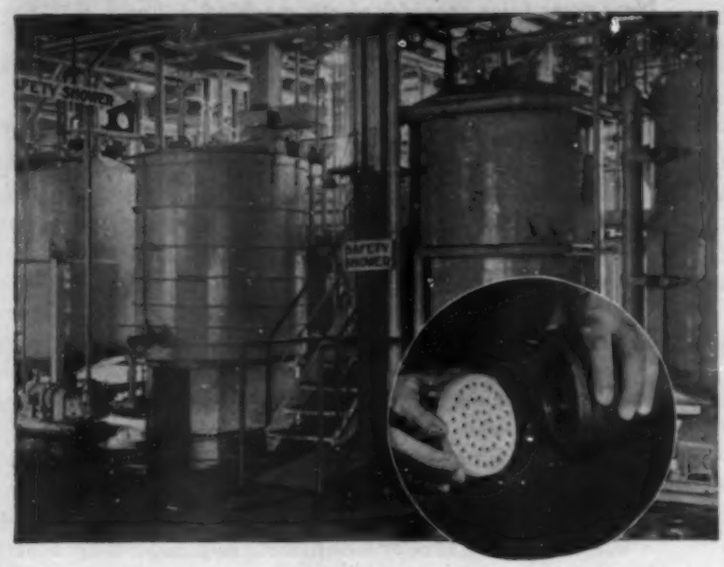
(Right) **THIS BOMBER WATER-STORAGE TANK,** fabricated of tough, durable LAMINAC*, is among the first commercial applications of this latest product of Cyanamid's research and development in the field of plastics. LAMINAC, a new thermosetting liquid resin, offers the outstanding advantage of remarkable bonding strength at mere contact pressure and the ease with which wet fabric or paper can be built up in a mold makes possible, for the first time, the production of laminated pieces in extremely complex shapes. Even without a filler, this cured resin shows no tendency to crack or craze and may be used to produce excellent laminates between steel or glass or simply by wrapping about a mold under tension without additional pressure. Further information is available on request.



(Below) **HIGH HEAT RESISTANCE** is a primary characteristic of aircraft engine harness parts molded of Cyanamid's mineral-filled MELMAC*. The compound used for the elbow liner and sleeve shown in the inset not only has the required dielectric strength and arc resistance, but will withstand temperatures up to 400° F. Further information on this and other Cyanamid Plastics is available on request.

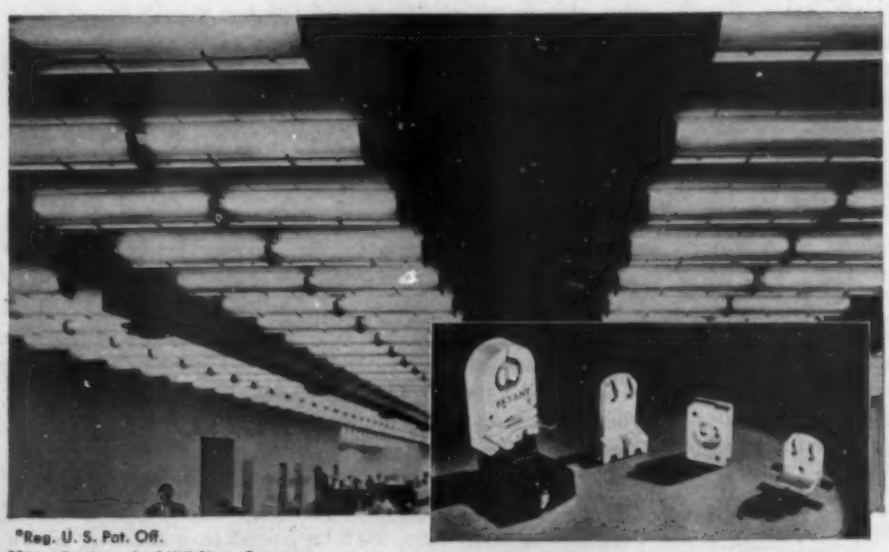
(Below) **STAIN RESISTANCE AND FREEDOM FROM ODOR AND TASTE** are among the characteristics of MELMAC 1077—an alpha-cellulose filled molding material used in making the shatter-resistant top chamber of this dual-unit Vaculator**, designed and built for the U. S. Navy by the Hill-Shaw Company. The smooth, hard, moisture-resistant surface of MELMAC makes it easy to keep clean.

Plastics Newsfront



(*Above*) **RESISTANCE TO CHEMICAL ATTACK** caused by vapors and fumes was one reason MELMAC 1077 was used for the nozzle in the shower head of this "Safety Shower" at the plant of the Calco Chemical Division of American Cyanamid. As shown in the inset, the MELMAC part is molded complete with holes and threads, ready for assembly in the cast iron head.

(*Above*) **PLASTICS ARE ON DISPLAY** at the new Plastics Section of the Navy Office of Procurement and Material. Established early last month to provide an information center for those wishing to do business with the Navy on plastics, the office of the new Plastics Section is located in Room 2227, Navy Building, Washington, D. C.



(*Left*) **FLUORESCENT TUBE SOCKETS** are molded of BEETLE* in a variety of types and styles to meet modern industrial needs. Excellent dielectric properties make this Cyanamid plastic ideal for many such electrical and lighting applications. If you are interested in the use of plastics in planning Tomorrow's designs, you will find helpful information in our book, Beetle Molding Materials.

*Reg. U. S. Pat. Off.
**Reg. Trademark of Hill-Shaw Company

AMERICAN CYANAMID COMPANY
PLASTICS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK, N. Y.
CYANAMID PLASTICS · Beetle · Melmac · Urac · Melurac · Laminac

The future of the injection industry

DRASTIC revisions of freezing order L-159 have virtually brought to a standstill production of all types of plastic molding machinery. On the face of it, it might appear that this strict war measure would act as a complete throttle on the progress of plastic machine developments for the duration. In actual point of fact, current research and development of new types of plastic injection molding equipment is being spurred more rapidly than ever before.

Progress in spite of restrictions

Because of the stringent regulation of all materials by priority, many projects are being perforce outlined only on paper. But users of plastics, molders and engineers should know that the driving spirit which has animated the plastic injection industry from its conception is still flourishing beneath all the recent rulings which have brought every phase of plastic manufacturing almost completely under Government regulation and control. So that designers and project engineers may have some idea of what the future holds for injection molding, MODERN PLASTICS has reviewed some of the engineering developments which are taking place in this field. Some of the projects outlined below may never reach the commercial stage in the form suggested here, but nevertheless they are indicative of the forward thinking being done by plastic engineers with a view to carrying on the tradition of phenomenal progress in the injection industry and to meeting the postwar demand for molded parts.

Since almost all of the ideas advanced in this paper are illustrated in patent literature, a list is appended covering some of the patents whose features are described herein. By studying the works of the various inventors listed below the discerning engineer may find many clues to the future injection machine, and to the types of product that will be injection molded after the war. Comparatively few of the wartime plastic applications have been produced by any very revolutionary methods. Chiefly the emphasis has been upon high production runs, even if of brief duration, by more or less established methods. Most up-to-date plastic injection machines in this country are being operated close to capacity. Actual production rates in many cases exceed the fondest estimates of last year. But by and large relatively few innovations in molding equipment have resulted from war molding demands.

Blowing and pressing of injected plastics

Perhaps the most unique development caused by wartime shortages has been the blowing and pressing of injection molded plastics while retaining the injection heat. Undoubtedly the future will see fully automatic machines for injection and blowing of plastic containers, perfume bottles, oil cans, tableware and all types of hollow product hitherto closed to thermoplastics.

Horn buttons, wall light-fixture plaques, decorative panels, drawer fronts and other fancy flat work may be made by a combination injection and pressing machine or stamp. A blank form is injected into an inexpensive plain mold made of aluminum or cast iron. While still retaining the injection heat, the blanks will be passed automatically to a single chilled decorating die cavity which will rapidly emboss elaborate designs on the still soft plastic. Thus one die of moderate cost may be made to serve in the place of present expensive 4- or 6-cavity injection molds. Such a stamping die need not incorporate the extensive workmanship found in present injection dies and will take care of the output of a 4- or 6-cavity mold forming the blanks.

New companies consider plastic machine design

Many concerns without previous experience in designing machinery for various types of injection work are now considering entering the field. It is very likely that one of these companies new to the plastic machinery industry, but with an industrial engineering background in other fields, may hit on a new or untried method of plastic molding which will be a material improvement over that indicated by present known research. Engineers should watch for announcements by concerns new to the plastic machinery field with a view to making critical judgments of the new equipment as it might make obsolete many current injection machines.

The adaptation of some related process principles to future plastic injection machines may be of great importance. Typical of this type of development is the use of ordinary aluminum die casting machinery for plastic injection. A preform or charge of plastics is prepared for molding by the heatronic process.[1] The charge then is dropped into the cold chamber where the metal is usually ladled, and the plunger is brought forward under high pressure and at very high speed under the action of a gas accumulator.[2] The plastic is forced into the cavity and there allowed to set or cure, depending on the material used. Since all the heat load necessary for the chemical or physical changes in the material was introduced into it before it was placed in the injection chamber, the cycles obtainable by this method almost surely will equal or exceed those of ordinary injection or jet molding. Since a minimum time elapses before the material enters the mold, no cold skin can form and full advantage may be taken of the quick, high heat obtainable through use of high frequency current.

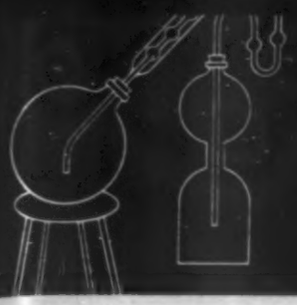
It is perfectly conceivable that a fully automatic machine will be developed wherein heatronically prepared pellets are mechanically delivered to the injection chamber. The technical difficulties encountered in the perfection of such a machine are certainly not a great deal more complicated than those already overcome in the average injection or die casting machine, or automatic compression molding machine.

Container type injection molding

Another development taking place also uses preheating of the mold charge. The material is placed in a container where it is warmed gradually to a temperature suitable for injection. The hot container then is placed in the molding machine and the prepared plastic forced into the mold cavity proper under pressure from a plunger. Using such a process, the hot charge may be placed in a chamber which is part of the mold and forced from the pot section of the mold to the cavity through a connecting passage.[3]

Another method of applying the container technique would be similar to the cold chamber (*Please turn to page 140*)

[1] See Meharg, V. E., "Heatronic molding," MODERN PLASTICS, *20*, 87ff. (March 1943).
[2] See Merrill, L. K., Wheeler, W. R., and Miller, G. C., "Wherefore injection molding," MODERN PLASTICS, *16*, 26ff. (Feb. 1939).
[3] See Norris, C. A., "Transfer molding of phenolic material," MODERN PLASTICS, *20*, 75ff. (April 1943).



Basic physical properties of laminates*

by PHILIP M. FIELD†

IN sharp contrast to the amount of information available on the physical properties of metals, the quantity of data on the properties of plastics is meager, even for the commercial grades which have been on the market for years. Such information is necessary before plastics can be widely used in applications requiring careful design, such as aircraft. As in other materials, the war has created serious shortages in the supply of most plastics, with the result that their use has been limited to applications where manufacturing or functional advantages are obtained. The necessity for judging whether a plastic is worthy of development for a particular application further increases the need for engineering information.

This paper is intended to contribute data on the more important physical properties of some laminates, including commercial grades C, L and X and the high strength laminates reinforced with paper, glass and asbestos (Table I). Data are presented on the tensile, edgewise compressive, flexural, bearing, shear and impact strengths. The effect of extreme service temperatures on these properties is indicated by data determined at high and low as well as at room temperature. Information is also given on the directional properties, the fatigue strength and the effect of slowly applied repeated stresses. The effect of variations in molding pressure on the physical properties of certain laminates is also discussed.

Test methods

All tests were conducted in accordance with Federal Specification L-P-406 entitled "Plastics, Organic; General Specification (Methods of Tests)" except as noted. Bearing tests were conducted with a $^1/_8$-in. diameter pin. Flatwise shear tests were conducted with the NAF shear tool which is similar to the Johnson-type tool. Edgewise shear tests were conducted on a specially designed shear tool which enables edgewise shear of thin specimens. The testing machine used for determining notched Izod impact strength was one having ranges of 110 ft.-lb. and 220 ft.-lb. capacity. The lower range was used, permitting determinations of absorbed energy to the nearest 0.5 ft.-lb.

Maximum and minimum values in tables indicate results of 2 tests unless otherwise noted. Impact figures are averages of 2 test values. Other values are for single test specimens.

Definitions

Yield strength in tension and compression is the stress at 0.007 in. per in. of strain or 76 percent of ultimate stress, which ever is less.

Secant modulus in tension and compression is the yield strength divided by the corresponding unit strain.

Bearing strength is the stress required to produce a deformation equal to 4 percent of the bearing pin diameter.

Modulus of rupture for a simple beam is calculated from the following formula:

$$s = \frac{Mc}{I} = \frac{3Pl}{2bd^2}$$

where P is the ultimate load in pounds, l is the span in inches, b is the width of the specimen in inches, and d is the thickness of the specimen in inches.

Modulus of elasticity in flexure is calculated from the following formula:

$$E = \frac{P'l^3}{48Iy}$$

where P' is 76 percent of ultimate, I is the moment of inertia, equal to $bd^3/12$, and y is the deflection at P'.

Specific strengths are calculated in this report as follows:

a. Specific ultimate strength, specific yield strength and specific secant modulus in tension and compression, and specific bearing strength are equal to the absolute value divided by the specific gravity of the material.

b. Specific modulus of rupture $= \dfrac{\text{modulus of rupture}}{(\text{specific gravity})^2}$.

c. Specific flexural yield strength $= \dfrac{\text{yield strength}}{(\text{specific gravity})^2}$.

d. Specific modulus of elasticity in flexure $= \dfrac{\text{modulus of elasticity}}{(\text{specific gravity})^2}$.

Effect of service temperatures

The service range of temperatures has been defined by the Army and Navy as +160° F. to −70° F. These limits are

TABLE I.—DESCRIPTION OF MATERIALS

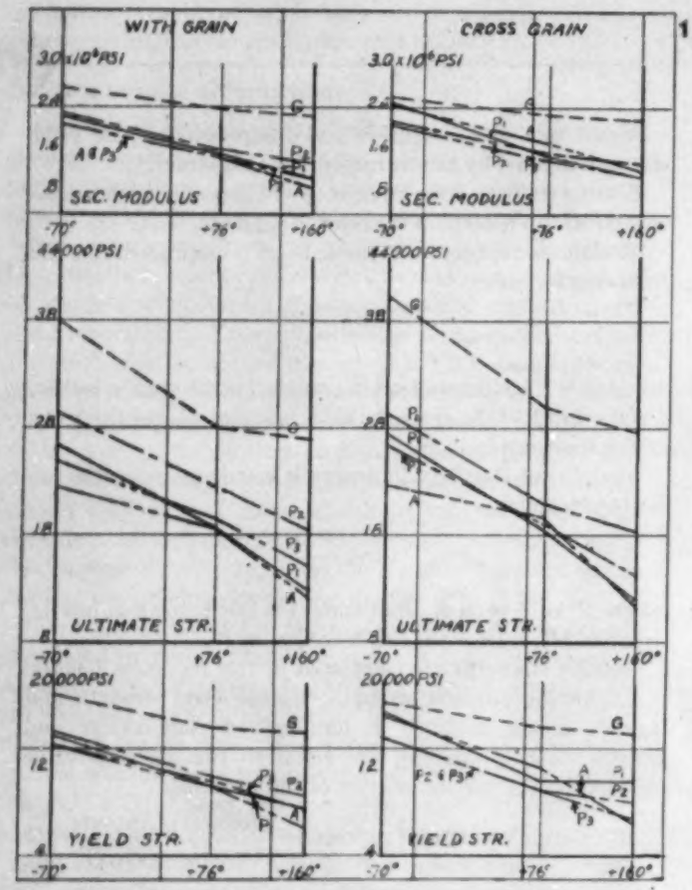
(Phenol-formaldehyde resin used as the bonding agent in all of these laminates)

Material designation	*Reinforcing material*	*Specific gravity*
A	Felted asbestos	1.61
C	"C" cotton fabric	1.38
G	O C 63 glass fibers, cotton fabric (11¼ oz./sq. yd.)	1.67
L	"L" cotton fabric	1.33
X	Paper	1.34
P1	Cross-banded high-strength paper	1.40
P2	Cross-banded high-strength paper	1.40
P3	Cross-banded high-strength paper	1.36
P4	Unidirectional high-strength paper	1.35

* Paper presented at the ANC-Industry Conference, sponsored by the Army-Navy-Civil Technical Subcommittee on Plastics, held in Philadelphia, Penna., on Feb. 9, 1943.

† Mechanical engineer, Naval Aircraft Factory.

actually not the extremes which have been measured, but it has been jointly agreed by the services that they constitute reasonable limits within which the properties of materials should be investigated. The upper limit of 160° F. may be reached in an aircraft structure operating in a desert or under tropical conditions, subjected to intense solar radiation for long periods of time. The lower limit is the approximate average temperature at an altitude of 50,000 feet. Actually, temperatures as low as −100° F. have occasionally been recorded at that altitude. Temperatures as low as −50° F. are occasionally found in northwest U. S. and north Canada.



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Temperature effects can be of 3 principal types: the immediate effect of an extreme temperature applied for a short period of time; the effect of an extreme temperature applied over a long period of time; and the permanent effects induced by cycles of varying temperature (thermal fatigue). Most of the data to be presented involve the first condition, which is a normal service condition. The effects of sustained temperature are not so well known. Only in special cases, such as engine parts, are materials used under conditions of sustained high temperatures; however, sustained low temperatures are common. In each case the permanent effects, if any, are of importance. Some data are presented herein. No data on thermal fatigue are known to be available, but tests are under way. Here again, possible permanent effects are sought.

In general it is found that the physical properties of plastics tend to improve as the temperature is lowered and to deteriorate as it is raised. This is true of compression, tension, flexure, fatigue, bearing and shear, but is usually reversed in the case of impact.

Compression. Figure 1 shows the effect of temperature on the compressive properties of 3 plastic materials. Curves P1, P2 and P3 all represent material reinforced with high-strength paper, molded at 250 p.s.i.; curve A a special asbestos felted material; and curve G a high-pressure material reinforced with parallel glass fibers and cotton fabric. This material is subsequently referred to as glass-reinforced material, or glass. The resin in all cases is phenol-formaldehyde.

In the case of the strongest material (glass), the ultimate strength varies from 38,400 p.s.i. at −70° F. to 28,200 p.s.i. at room temperature (approximately 76° F.) and 27,300 p.s.i. at +160° F. The corresponding values for the best high-strength paper are 29,500, 22,600 and 18,500 p.s.i., respectively. It can be seen that the strength gradient with temperature tends to decrease in the case of the glass and is approximately constant for high-strength paper. It can also be seen that the trend lines are almost parallel, permitting the determination of an approximate strength gradient applicable to all of these materials. This is found to be approximately 48 p.s.i. per degree F.

The same general trend is found in the yield strength

1—*Effect of temperature on compressive properties (Table II)*

TABLE II.—COMPRESSIVE PROPERTIES

Material			Low temperature (−70° F.) Ult. str. p.s.i.	Low temperature (−70° F.) Yld. str. p.s.i.	Low temperature (−70° F.) Sec. mod. p.s.i. × 10⁶	Room temperature (+76° F.) Ult. str. p.s.i.	Room temperature (+76° F.) Yld. str. p.s.i.	Room temperature (+76° F.) Sec. mod. p.s.i. × 10⁶	High temperature (+160° F.) Ult. str. p.s.i.	High temperature (+160° F.) Yld. str. p.s.i.	High temperature (+160° F.) Sec. mod. p.s.i. × 10⁶
P1	W.G.	Max.	26,640	15,660	2.237	19,850	10,950	1.564	13,380	8,400	1.200
		Min.	26,000	15,550	2.221	18,900	10,640	1.520	12,900	8,210	1.173
	C.G.	Max.	27,700	18,420	2.631	18,850	10,930	1.561	12,430	7,890	1.127
		Min.	27,630	16,440	2.350	18,800	10,900	1.557	12,020	7,880	1.126
P2	W.G.	Max.	30,300	16,190	2.310	22,800	11,400	1.629	18,900	9,860	1.409
		Min.	28,800	15,480	2.211	22,500	11,200	1.600	18,050	9,030	1.290
	C.G.	Max.	29,600	15,900	2.371	21,550	11,200	1.600	18,700	9,280	1.326
		Min.	28,800	14,450	2.074	20,950	10,700	1.529	18,680	9,110	1.301
P3	W.G.	Max.	26,530	14,830	2.119	19,800	11,550	1.650	15,300	8,380	1.197
		Min.	24,800	14,770	2.110	19,700	10,250	1.465	14,500	8,220	1.175
	C.G.	Max.	26,850	15,200	2.174	20,650	10,550	1.507	15,100	8,140	1.163
		Min.	26,150	14,875	2.125	18,100	10,400	1.485	14,700	7,650	1.093
A	W.G.	Max.	22,900	15,000	2.143	18,960	10,680	1.526	12,340	6,840	0.997
		Min.	22,700	14,600	2.090	18,900	10,470	1.496	12,230	6,690	0.956
	C.G.	Max.	23,630	17,260	2.466	19,730	12,340	1.763	13,370	7,940	1.317
		Min.	22,200	17,070	2.439	19,250	12,010	1.716	10,060	7,640	1.133
G	W.G.	Max.	39,900	20,100	2.870	29,400	16,500	2.357	27,700	15,710	2.240
		Min.	36,900	18,400	2.630	27,000	16,380	2.340	26,940	15,450	2.207
	C.G.	Max.	40,400	18,800	2.685	30,760	16,520	2.360	27,600	15,900	2.270
		Min.	40,250	17,700	2.530	29,700	15,710	2.244	...	15,140	2.162

(defined arbitrarily as the stress at 0.007 in. per in. elongation). The glass is also found to be superior with regard to this property, the values being 19,200, 16,400 and 15,600 p.s.i. at low, room and high temperatures, compared with 15,800, 11,300 and 9400 p.s.i. for the high-strength paper.

The variations in secant modulus are shown at the top of Fig. 1. The secant modulus is arbitrarily taken at 0.007 in. per in. strain and therefore shows exactly the same relative variations as the yield strength.

Tension. The variations in tensile strength are shown in Fig. 2. The ultimate tensile strength of the glass material is 46,400 p.s.i. at −70° F., falling off to 39,500 and 29,200 p.s.i. at room temperature and +160°, respectively. The best high-strength paper has corresponding values of 29,300, 25,000 and 18,000 p.s.i. Between room temperature and +160° F. the percentage decrease for glass is 26 percent and for high-strength paper 24 percent.

Flexure. It will be noted that whereas in compression and tension the glass-reinforced material has properties approximately comparable in the 2 principal directions, the flexural properties are considerably higher "with grain" than "cross grain." This is due to the symmetrical pattern followed in laying the glass fibers. An even number of layers is used and the parallel layers are placed symmetrically with respect to the center line. The result is to make the average effective distance of the fibers from the neutral axis greater in one direction than in the other. This effect decreases as the thickness of the sheet increases. (*Please turn to next page*)

2—*Effect of temperature on tensile properties (Table III).*
3—*Effect of temperature on flexure properties (Table IV)*

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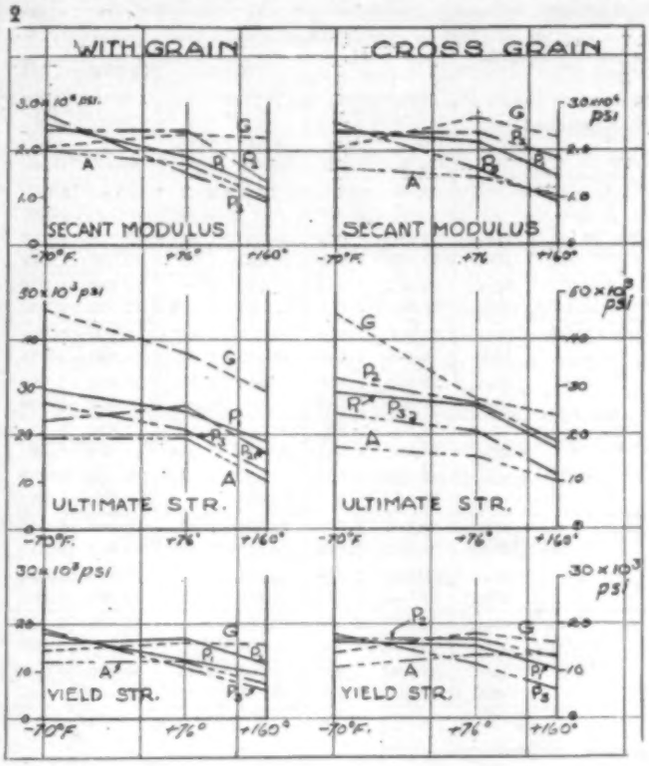

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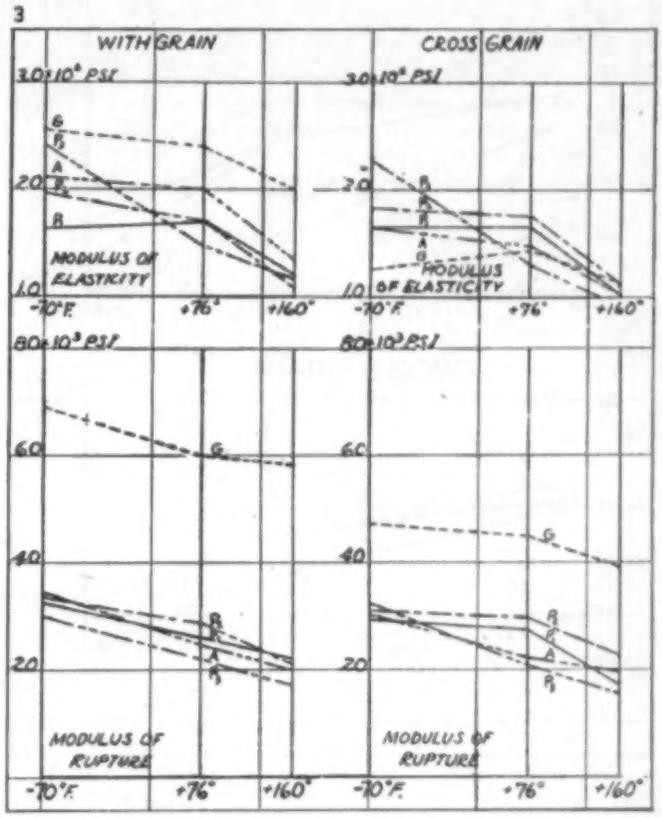


TABLE III.—TENSILE PROPERTIES

Material			Low temperature (−70° F.) Ult. str.	Yld. str.	Sec. mod.	Elong.	Room temperature (+76° F.) Ult. str.	Yld. str.	Sec. mod.	Elong.	High temperature (+160° F.) Ult. str.	Yld. str.	Sec. mod.	Elong.
			p.s.i.	p.s.i.	p.s.i.	%	p.s.i.	p.s.i.	p.s.i.	%	p.s.i.	p.s.i.	p.s.i.	%
P1	W.G.	Max.	30,700	18,400	2.629	0.0	25,500	14,200	2.030	0.5	18,050	13,280	1.897	0.0
		Min.	28,000	17,170	2.453	0.0	24,600	12,510	1.787	0.0	17,880	11,370	1.625	0.0
	C.G.	Max.	29,200	17,150	2.450	0.0	26,150	17,300	2.470	0.5	17,420	10,750	1.535	0.5
		Min.	29,200	16,680	2.383	0.0	25,750	14,200	2.030	0.5	17,120	9,900	1.414	0.0
P2	W.G.	Max.	23,700	16,620	2.530	0.0	27,950	18,270	2.610	0.5	20,200	11,970	1.710	0.0
		Min.	21,850	16,020	2.289	0.0	27,350	15,450	2.205	0.0	16,900	11,200	1.600	0.0
	C.G.	Max.	32,200	17,380	2.483	0.0	27,250	17,470	2.496	0.5	18,400	13,300	1.900	0.0
		Min.	31,800	16,600	2.371	0.0	25,500	16,600	2.370	0.5	18,300	12,750	1.820	0.0
P3	W.G.	Max.	27,450	19,300	2.760	0.0	21,000	11,270	1.610	1.5	13,400	6,800	0.971	1.5
		Min.	26,750	18,900	2.700	0.0	20,500	11,240	1.605	0.5	10,520	5,110	0.730	1.0
	C.G.	Max.	24,800	18,100	2.590	0.0	20,830	11,860	1.694	1.0	12,920	6,590	0.941	1.0
		Min.	24,150	17,700	2.530	0.0	19,470	11,260	1.609	0.5	10,570	5,930	0.847	1.0
A	W.G.	Max.	20,800	14,200	2.029	1.5	19,550	12,920	1.845	1.0	10,550	7,120	1.017	1.0
		Min.	18,730	13,120	1.874	1.5	18,800	11,970	1.710	0.5	9,910	7,010	1.001	0.5
	C.G.	Max.	16,680	11,940	1.706	1.0	15,250	10,370	1.482	1.0	11,250	7,340	1.049	1.0
		Min.	16,180	11,680	1.669	0.5	14,800	10,250	1.465	0.5	10,590	7,100	1.014	0.5
G	W.G.	Max.	48,200	15,900	2.271	..	39,600	17,340	2.477	...	30,250	16,300	2.329	0.0
		Min.	44,700	13,850	1.979	0.0	39,400	16,150	2.307	..	28,250	16,280	2.326	0.0
	C.G.	Max.	45,900	14,480	2.070	..	30,600	19,810	2.830	0.0	26,700	16,150	2.307	0.0
		Min.	45,100	14,000	2.000	0.0	29,500	18,100	2.586	0.0	22,750	16,080	2.297	0.0

Both the "with grain" and "cross grain" moduli of rupture for the glass material are considerably higher than for the high-strength paper laminate. Comparing the cross grain values at room temperature, the glass is better than the best high-strength paper by 51 percent. This percentage increases at elevated temperatures, although the absolute values for both materials decrease. Comparison of the materials on the basis of specific flexural strength shows the glass to be better at +160° F. by approximately 27 percent.

In general, the modulus of elasticity is found to decrease as the temperature increases, the change per degree becoming greater as the temperature approaches +160° F. These data, however, show considerable scatter and further test work is required to establish the trends definitely.

The data on modulus of elasticity show considerable variations between different high-strength paper materials supplied by various laminators, especially at low temperature. These data are calculated from load-deflection curves using the formula $y = \frac{Pl^3}{48EI}$ for y corresponding to 76 percent of the modulus of rupture.

Bearing. The variation in bearing strength with temperature is shown in Fig. 4. For the glass material, the "with grain" bearing strength decreases approximately 96 p.s.i. per degree, the "cross grain," 49 p.s.i. per degree. For the high-strength paper materials, the average bearing strength gradi-

4—Effect of temperature on bearing properties (Table V)

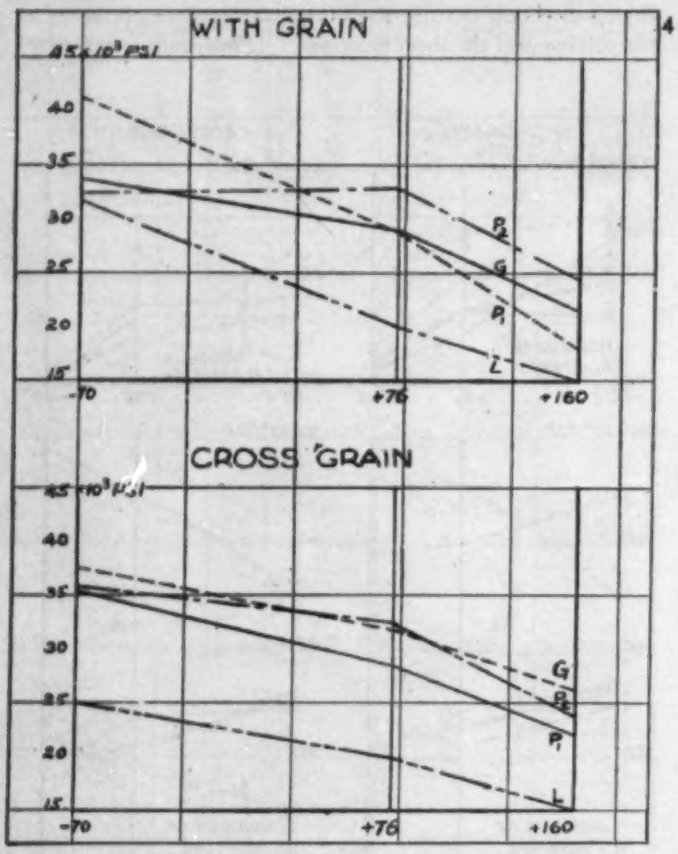


TABLE IV.—FLEXURAL PROPERTIES

Material			Low temperature (−70° F.) Mod. rupture p.s.i.	Low temperature (−70° F.) Mod. elast. p.s.i. × 10⁶	Room temperature (+76° F.) Mod. rupture p.s.i.	Room temperature (+76° F.) Mod. elast. p.s.i. × 10⁶	High temperature (+160° F.) Mod. rupture p.s.i.	High temperature (+160° F.) Mod. elast. p.s.i. × 10⁶
P1	W.G.	Max.	32,380	1.700	25,700	1.41	22,720	1.155
		Min.	32,300	1.658	25,650	1.38	20,050	1.017
	C.G.	Max.	29,530	1.662	27,400	1.76	17,300	1.072
		Min.	29,050	1.587	27,300	1.618	17,270	1.038
P2	W.G.	Max.	34,500	1.970	29,400	1.89	21,200	1.307
		Min.	34,000	1.942	27,400	1.83	19,680	1.294
	C.G.	Max.	30,800	1.840	31,010	1.78	23,400	1.186
		Min.	30,500	1.831	28,430	1.66	20,900	0.956
P3	W.G.	Max.	30,300	2.43	22,660	1.36	17,800	1.080
		Min.	30,100	2.335	21,790	1.338	15,600	0.894
	C.G.	Max.	33,050	2.30	21,820	1.32	17,000	0.898
		Min.	31,550	2.21	20,520	1.305	15,400	0.815
A	W.G.	Max.	36,800	2.220	25,500	1.87	21,950	1.340
		Min.	34,550	1.978	24,370	1.82	20,950	1.312
	C.G.	Max.	30,250	1.728	22,420	1.51	19,370	1.050
		Min.	29,950	1.613	21,840	1.42	19,000	1.022
G	W.G.	Max.	70,400	2.570	63,000	2.51	62,700	2.100
		Min.	69,000	2.560	58,000	2.30	56,200	2.060
	C.G.	Max.	47,500	1.290	45,000	1.46	39,600	1.125
		Min.	47,300	1.280	44,700	1.45	38,400	1.103

TABLE V.—SHEAR AND BEARING STRENGTHS

Material			Shear: Flatwise Low temp. (−70° F.) p.s.i.	Shear: Flatwise Room temp. (+76° F.) p.s.i.	Shear: Flatwise High temp. (+160° F.) p.s.i.	Shear: Edgewise Low temp. (−70° F.) p.s.i.	Shear: Edgewise Room temp. (+76° F.) p.s.i.	Shear: Edgewise High temp. (+160° F.) p.s.i.	Bearing: Low temp. (−70° F.) p.s.i.	Bearing: Room temp. (+76° F.) p.s.i.	Bearing: High temp. (+160° F.) p.s.i.
P1	W.G.	Max.	17,220	12,640	9,375	16,750	14,200	11,430	34,300	28,780	23,800
		Min.	16,570	12,270	8,380	16,060	14,150	10,750	33,200	28,580	18,850
	C.G.	Max.	18,200	12,950	11,350	18,400	14,350	11,320	35,400	30,200	22,580
		Min.	16,900	12,900	10,100	16,850	13,100	11,190	...	26,950	20,300
P2	W.G.	Max.	18,800	13,600	10,650	18,135	14,825	11,220	32,600	33,300	26,150
		Min.	18,570	13,525	9,880	17,300	14,250	11,020	...	32,600	23,000
	C.G.	Max.	18,350	13,925	11,420	18,800	15,300	11,320	35,850	33,500	23,100
		Min.	17,450	13,100	10,850	17,920	15,000	11,240	...	32,450	21,650
P3	W.G.	Max.	17,350	11,550	10,900	18,950	11,980	9,300	...	...	...
		Min.	16,100	11,360	10,300	17,750	11,920	9,130	...	...	...
	C.G.	Max.	16,550	11,930	10,800	16,800	13,140	10,100	...	...	...
		Min.	14,850	11,370	10,670	16,800	11,030	9,720	...	...	...
A	W.G.	Max.	17,410	15,700	12,420	16,530	13,650	10,270	41,900	31,200	26,400
		Min.	17,070	15,030	11,720	16,110	13,500	9,960	38,500	30,500	24,000
	C.G.	Max.	17,850	16,120	13,600	17,920	14,460	10,460	31,900	31,100	21,900
		Min.	17,180	16,020	13,380	16,520	13,525	10,220	31,600	29,600	20,200
G	W.G.	Max.	19,000	17,950	16,730	14,300	13,900	14,000	41,400	28,800	19,900
		Min.	18,900	16,470	15,730	13,500	13,000	13,710	37,300[b]	28,100	15,700[a]
	C.G.	Max.	22,000	18,430	16,450	17,150	16,120	15,100	38,700	31,900	28,000
		Min.	20,400	17,400	15,920	16,500	15,260	14,940	34,700[a]	31,300	24,800[b]

[a] Range of 3 values. [b] Range of 4 values.

ent "with grain" is approximately 16 p.s.i. per degree from −70° F. to +76° F. and 95 p.s.i. from +76° F. to +160° F.

In determining the bearing strength of high-strength paper, the specimens frequently fail in tension before the required deformation takes place. This test is conducted with a 1/8-in. pin on a specimen 1/8 in. thick and 1 in. wide, maximum loads running up to 550 pounds. Assuming an average distribution over the remaining area of the specimen, the tensile stress is then about 5500 p.s.i. The occurrence of tensile failures under these conditions indicates that high concentrated stresses are produced. The concentration of stress is due to poor elongation of the material which prevents the distribution of stress over the tensile area, and results in progressive failure. The point is emphasized here because it demonstrates the necessity of an investigation to establish the parameters needed to determine whether a joint will be critical in bearing.

Shear. The effect of temperature on the shear strength is indicated in Fig. 5. The general tendency is for the strength to decrease continuously as the temperature increases. For high-strength paper, the edgewise and flatwise "with grain" and "cross grain" values are approximately equal at a given temperature. The strength gradient for each condition is approximately 30 p.s.i. per degree F. In the case of glass material, the edgewise shear is less than the flatwise shear, the values with grain at 76° F. being 13,400 and 17,200 p.s.i., respectively. The edgewise shear strength is only slightly affected by temperature.

Impact. Except for the glass-reinforced material, the general effect of temperature on impact strength is the reverse of that for other properties. This is in accordance with common experience—that materials tend to become stiffer and more brittle at low temperatures. The magnitude of the drop in strength is indicated in Fig. 6.

In the case of the glass material, the effect is the reverse of that for other materials. Examination of the facewise impact specimens of the glass material shows considerable variation in the type of failure produced. In some cases the specimen delaminates completely and few fibers are broken, while in others the delamination is accompanied by rupture of many of the fibers. A wide variation is found in the test values obtained from these 2 types of failure, the delamination generally taking less energy even though it involves shear over a large aggregate area.

The edgewise impact strength of high-strength paper is low at all temperatures.

Effect of sustained heat on flexural strength. The limit of +160° F. applies to the upper service temperature for the airplane as a whole. There are locations within the airplane,

5—*These graphs show effect of temperature on shear strength (Table V).* **6**—*Effect of temperature on Izod-notched impact strength is shown here (see Table VI)*

5

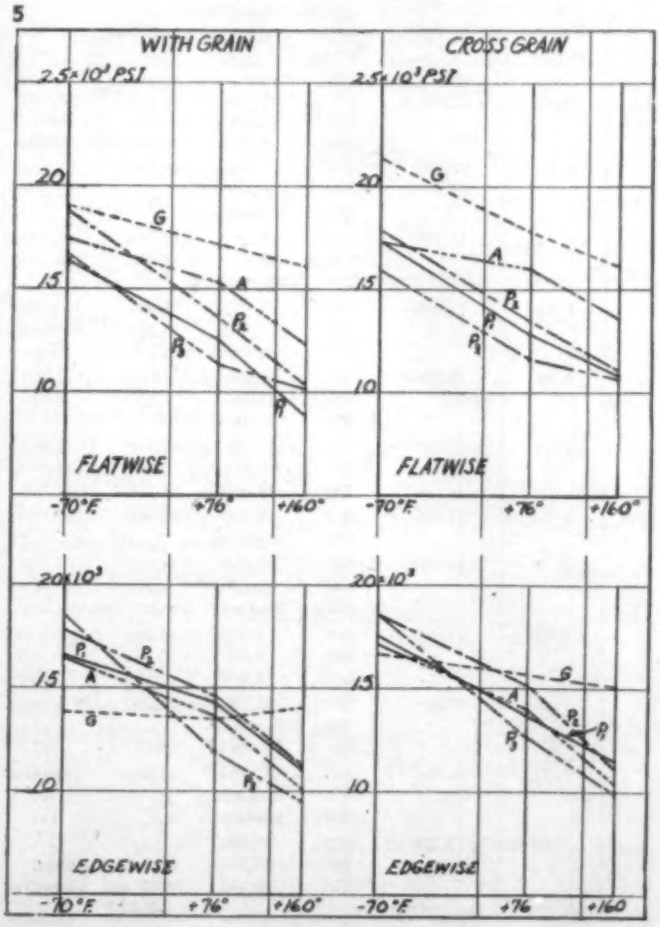
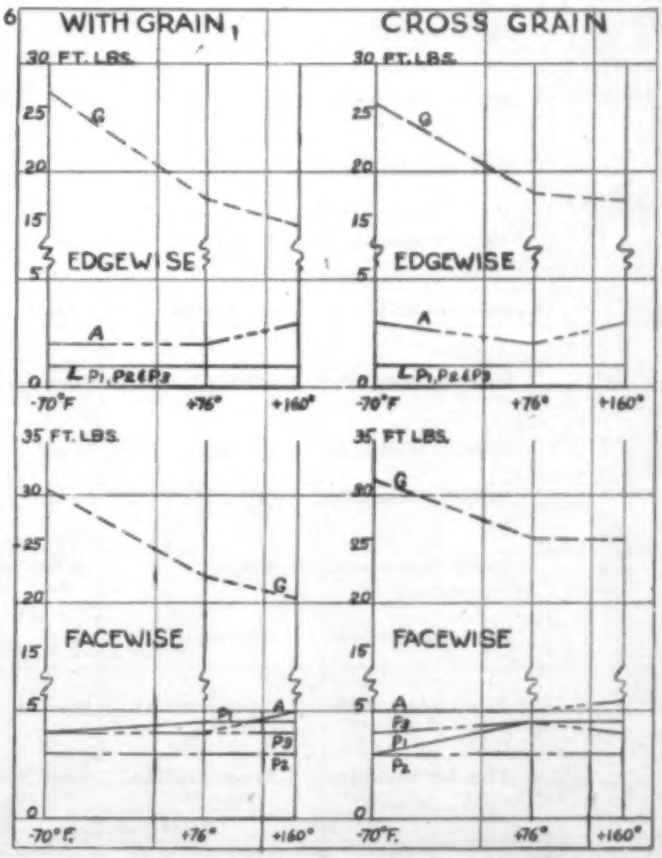


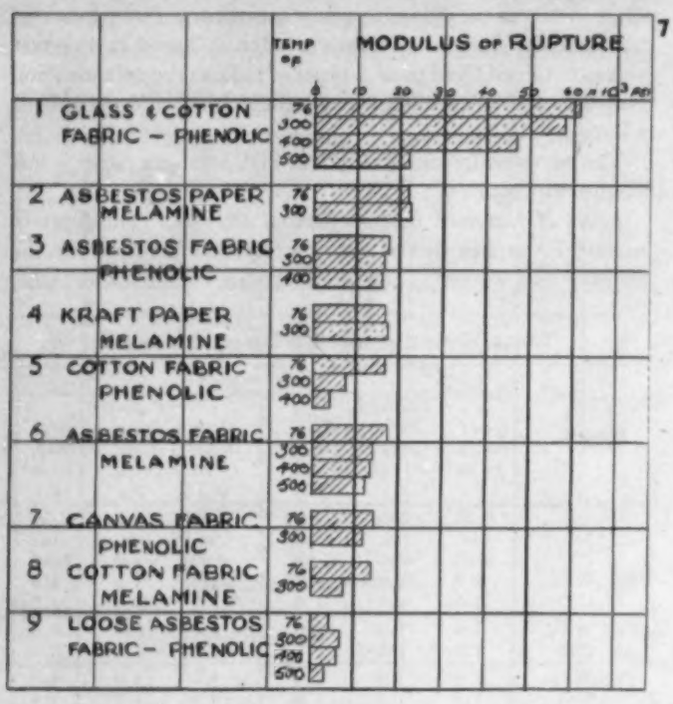
TABLE VI.—IZOD-NOTCHED IMPACT STRENGTH

Material		Impact strength					
		Edgewise			Facewise		
		Low temp. (−70° F.)	Room temp. (+76° F.)	High temp. (+160° F.)	Low temp. (−70° F.)	Room temp. (+76° F.)	High temp. (+160° F.)
		ft.-lb./in. notch	ft.-lb./in. notch	ft.-lb./in. notch	ft.-lb./in. notch	ft.-lb./in. notch	ft.-lb./in. notch
P1	W.G.	1.0	1.0	1.0	4.0	4.5	4.5
	C.G.	1.0	1.0	1.0	3.0	4.5	4.5
P2	W.G.	1.0	1.0	1.0	3.0	3.0	3.0
	C.G.	1.0	1.0	1.0	3.0	3.0	3.0
P3	W.G.	1.0	1.0	1.0	4.0	4.0	4.0
	C.G.	1.0	1.0	1.0	4.0	4.5	4.0
A	W.G.	2.0	2.0	3.0	4.0	4.0	5.0
	C.G.	3.0	2.0	3.0	5.0	5.0	5.5
G	W.G.	33.5	22.0	20.0	29.0	23.0	27.5
	C.G.	31.0	22.5	20.5	31.5	32.5	31.0

6



however, where higher temperatures are encountered. In order to investigate the effect of elevated temperatures on plastic laminates, flexural tests were conducted on specimens which had been subjected for 8 hr. to temperatures of 300° F., 400° F. and 500° F. The results are shown in Fig. 7. The general effect of high heat on phenolic laminates is first to complete the cure of the resin, then to char cellulosic fillers, at the same time driving off various gaseous products which result from the heating. If the construction is such that these gases cannot escape, the material blisters. Ordinary phenolic laminates blister at about 350° F. Blistering can be prevented by using a porous heat-resistant filler such as loosely woven asbestos fabric when this is practicable from the strength standpoint, as in some secondary structural applications. Laminates can also be made more resistant to heat effects by slow curing and after-baking.


TEMP °F
MODULUS OF RUPTURE
1 GLASS & COTTON FABRIC – PHENOLIC
2 ASBESTOS PAPER MELAMINE
3 ASBESTOS FABRIC PHENOLIC
4 KRAFT PAPER MELAMINE
5 COTTON FABRIC PHENOLIC
6 ASBESTOS FABRIC MELAMINE
7 CANVAS FABRIC PHENOLIC
8 COTTON FABRIC MELAMINE
9 LOOSE ASBESTOS FABRIC – PHENOLIC
7

The effect of sustained heat and repeated thermal cycles on the physical properties of plastics is considered important and should be investigated. At the present time tests are under way to determine the tensile, flexural and compressive properties of materials subjected to 50 and 100 cycles of alternate heating and cooling to +160° F. and −70° F.

Directional properties

The designer who is accustomed to working with essentially isotropic materials is vitally interested in directional properties where these exist in new materials. The problem of proper grain directions in wood construction is vital. Plastic laminates often have definite grain also.

The construction of the bi-directional, high-strength paper and glass fiber-cotton laminates is intended to produce a sheet with uniform properties in 2 principal directions. Investigation of the properties at 45° to the principal directions shows that the former material is essentially isotropic whereas the latter shows greatly reduced properties. In this material the "with grain" and "cross grain" compressive ultimates are 24,700 and 23,400 p.s.i., respectively, while at 45° the ultimate is 18,600 p.s.i. Corresponding values in tension are 39,500 and 20,000 p.s.i. compared with 16,300 p.s.i. at 45°. The corresponding yield strengths in compression are

TABLE VII.—EFFECT OF SUSTAINED HEAT ON FLEXURAL STRENGTH

Designation, on Fig. 7	Description			Specific gravity	Flexural strength				
					As recd.	After sustained heat			
	Resin	Filler	Form			Temp.	1 Hr.	3 Hr.	8 Hr.
					p.s.i.	°F	p.s.i.	p.s.i.	p.s.i.
1	Phenol-formaldehyde	Glass and cotton	Alternating layers of fabric and glass	1.66	61,900	300	49,400	56,400	57,500
						400	40,000	50,800	46,700
						500	38,800	31,000	22,000
2	Melamine-formaldehyde	Asbestos	Paper sheet	1.88	22,100	300	25,700	24,750	22,300
						400	Blistered	...	...
						500	Blistered	...	...
3	Phenol-formaldehyde	Asbestos	Fabric	1.54	17,900	300	18,300	16,500	16,300
						400	18,000	17,900	16,200
						500	Blistered	...	...
4	Melamine-formaldehyde	Kraft paper	Macerated sheet	1.41	17,200	300	18,500	18,500	17,600
						400	17,150	15,800	Blistered
						500	Blistered	...	...
5	Phenol-formaldehyde	Cotton fibers	Fabric	1.38	17,100	300	16,200	17,600	7,700
						400	15,500	6,350	4,540
						500	Blistered	...	...
6	Melamine-formaldehyde	Asbestos	Fabric	1.85	16,700	300	17,900	16,500	14,000
						400	16,250	16,300	13,900
						500	14,800	14,300	12,500
7	Phenol-formaldehyde	Canvas	Fabric	1.30	14,500	300	13,200	14,800	12,000
						400	Blistered	...	...
8	Melamine-formaldehyde	Cotton fibers	Fabric	1.55	14,300	300	13,800	14,600	7,550
						400	13,550	7,900	...
						500	Blistered	...	...
9	Phenol-formaldehyde	Asbestos	Loose fabric	1.33	5,050	300	5,300	6,600	6,900
						400	6,400	6,345	6,350
						500	4,500	3,700	2,640
..	Phenol-formaldehyde	Kraft paper	Sheet	1.39	25,500	300	24,700	24,100	Blistered
						400	Blistered	...	...
						500	Blistered	...	...
..	Phenol-formaldehyde	Asbestos NEMA grade A	Paper sheet	1.71	20,000	300	22,600	24,000	Blistered
						400	Blistered	...	...
						500	Blistered	...	...
..	Phenol-formaldehyde	Asbestos NEMA grade "AA"	Fabric	1.65	19,550	300	22,800	...	...
						400	20,350	No more material	
						500	20,150	Will not blister at 500° F.	

16,100, 15,300 and 6700 p.s.i., and in tension are 16,700, 19,000 and 7200 p.s.i.

The reduction of strength at 45° is considerably greater than that of plywood. Three-ply mahogany-poplar having a "with grain" strength of 8100 p.s.i. and a "cross grain" strength of 5900 p.s.i. is found to have a 45° strength of 4900 p.s.i. Corresponding values for seven-ply mahogany were 8200, 6500 and 4500 p.s.i. The low strength of the glass material at 45° to the principal directions imposes serious limitations to its use in aircraft structures.

The other materials in Fig. 8 are: commercial grade X paper-base phenolic, commercial grade C fabric-base phenolic and a special felted asbestos phenolic marked A. The compressive ultimate and yield strengths for the C and A materials are comparable in the 3 directions. The compressive yield strength for the X material is greater "cross grain" than "with grain," the 45° value being intermediate.

TABLE VIII.—DIRECTIONAL PROPERTIES OF REINFORCED PLASTICS

Material	Angle between stress and grain		Tension			Compression		
			Ult. str.	Yld. str.	Sec. Mod.	Ult. str.	Yld. str.	Sec. mod.
	deg.		p.s.i.	p.s.i.	p.s.i. $\times 10^6$	p.s.i.	p.s.i.	p.s.i. $\times 10^6$
G	0	Max.	39,600	17,340	2.477	24,700	16,310	2.330
		Min.	39,400[a]	16,150	2.307	24,630	15,920	2.274
	45	Max.	16,370	7,900	1.128	19,020	6,790	0.970
		Min.	16,220	6,520	0.932	18,350	6,500	0.929
	90	Max.	30,600[a]	19,810	2.830	23,700	15,540	2.220
		Min.	29,500[a]	18,100	2.586	23,150	15,100	2.156
P1	0	Max.	21,850	15,750	2.340	19,850	10,950	1.564
		Min.	18,480[a]	14,020	2.250	18,900	10,640	1.520
	45	Max.	24,900	15,100	2.160	16,530	10,420	1.489
		Min.	23,400	14,780	2.110	16,420	10,310	1.473
	90	Max.	22,300[a]	14,900	2.130	18,850	10,930	1.561
		Min.	22,050[a]	14,300	2.043	18,800	10,900	1.557
C	0	Max.	14,650	7,360	1.051	24,050	6,460	0.923
		Min.	...	...	...	23,800	5,460	0.780
	45	Max.	9,580	5,700	0.814	21,550	5,590	0.799
		Min.	...	...	..	21,200	5,250	0.750
	90	Max.	8,325	5,440	0.777	20,500	6,340	0.906
		Min.	7,960	5,340	0.763	20,050	6,120	0.874
X	0	Max.	25,150	15,180	2.170	27,100	8,580	1.226
		Min.	22,350	14,350	2.050	26,900	8,470	1.210
	45	Max.	18,450	12,700	1.814	28,450	9,540	1.363
		Min.	18,250	11,350	1.621	28,150	9,525	1.361
	90	Max.	15,820	11,400	1.635	28,000	11,070	1.581
		Min.	14,200[a]	10,080	1.440	27,250	10,350	1.479
A	0	Max.	17,250	11,630	1.661	20,000	12,150	1.736
		Min.	16,920[a]	11,480	1.640	19,550	11,800	1.687
	45	Max.	14,780	10,250	1.464	19,330	11,000	1.571
		Min.	13,470[a]	9,825	1.404	19,300	10,780	1.540
	90	Max.	13,400	9,540	1.363	20,000	10,680	1.526
		Min.	13,360	9,300	1.329	18,370	10,470	1.496

[a] Shoulder failure.

Fatigue strength

Before presenting data on the fatigue strength, the technique of fatigue testing and some of the problems encountered will be discussed briefly.

The determination of fatigue strength is ordinarily done in a rotating-beam, constant-stress machine or a repeated-flexure or constant-strain machine. The stresses in both cases are flexural stresses. The usual rotary-beam machine permits

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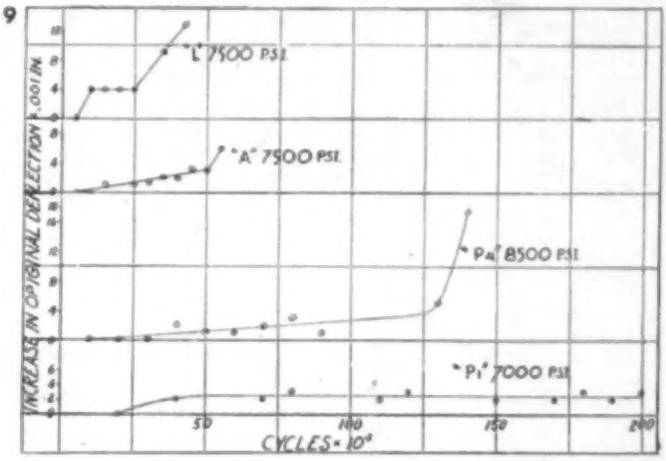

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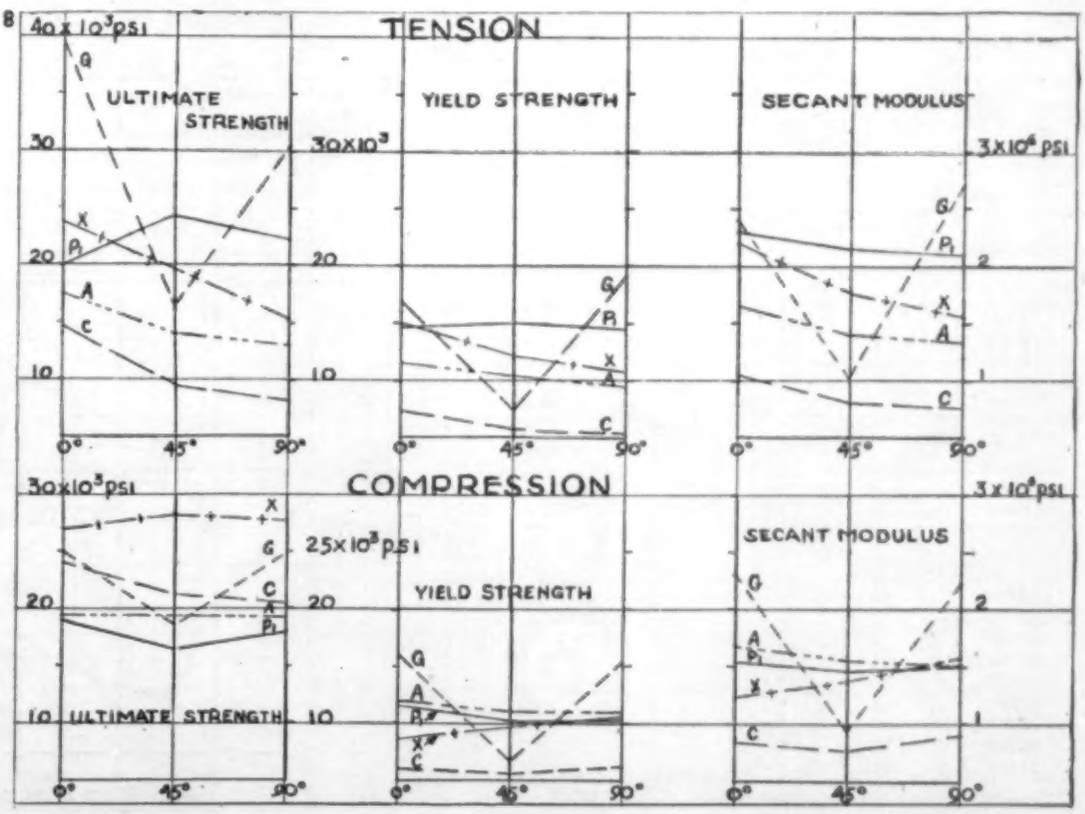


7—Results of tests made to determine the effect of 8 hours of sustained heat on flexural strength (see Table VII). 8—Chart showing the directional properties in tension and compression (see Table VIII). 9—Graph shows the increase in deflection after fatigue (Table IX)

testing at speeds of 10,000 or 3400 r.p.m. and preliminary data indicate that results obtained at both speeds are comparable. Flexural machines operate at a speed of 1750 r.p.m.

In a rotary-beam specimen, every point on a circumference is successively subjected to the maximum stress during each rotation. If the specimen is cut from sheet material such as a laminate, every quarter cycle the specimen passes from a condition similar to flatwise flexure to a condition similar to edgewise flexure, the intermediate condition consisting of varying combinations of the two. It is obvious that such a test is much more severe than a flatwise flexural fatigue test and resulting values will tend to be lower. This will result in lower allowables than would be obtained from flat specimens. Since the latter simulate better the operating condition of most parts of aircraft structures, it is considered that flatwise fatigue strengths are the better ones to use in design. Correlations between results obtained by both methods may be obtained in the future for materials of homogeneous cross section, but for non-homogeneous composite laminates, individual correlations would be required for each. The rotary-beam test would thus be superfluous.

The Krouse fatigue machine is equipped with an automatic shut-off actuated when the specimen breaks in two. However, it is not correct to define fatigue failure in terms of the physical separation of the specimen into 2 pieces. Long before actual fracture occurs, minute cracks develop extending from the surface toward the neutral axis. In some materials, these cracks are readily discernible; in others they are not. The cracks, of course, relieve the stress and additional reversals are not at the required predetermined stress level.

The question is thus raised as to the definition of failure in a sheet fatigue test. In setting up these tests, it is customary to calculate the load required to induce a desired stress. This load is then applied to the specimen, the deflection noted, and the eccentricity adjusted to give the desired deflection. As would be expected, the re-application of the original load to a specimen which has developed cracks will cause a deflection greater than the original. This can serve as a basis for determining failure. The specimen can be considered as having failed when the deflection produced by the initial load shows a marked increase in its rate of change.

Figure 9 shows the increase in deflection after fatigue. Curve L represents a commercial grade L laminate; curve A a special felted asbestos; curve P4 a unidirectional high-strength paper. At the indicated stress, these materials are considered to have failed at 250,000, 500,000 and 1,300,000 cycles, respectively. Curve P1 shows a cross-banded high-strength paper which at 7000 p.s.i. exceeded 2,000,000 cycles without failure. Attention is called to the fact that the horizontal portion of the curve means that fatigue is essentially at constant stress. However, the intensity of the stress is lower than that intended, as will be shown.

It is generally known that plastics have much better damping capacity than metals. A quantitative measure (inverse) of this is given by the resonance amplification factor, which is defined as the ratio of the stress in a member vibrating in resonance with an exciting force, to the static stress which would be produced by that force. Lazan[1] has determined

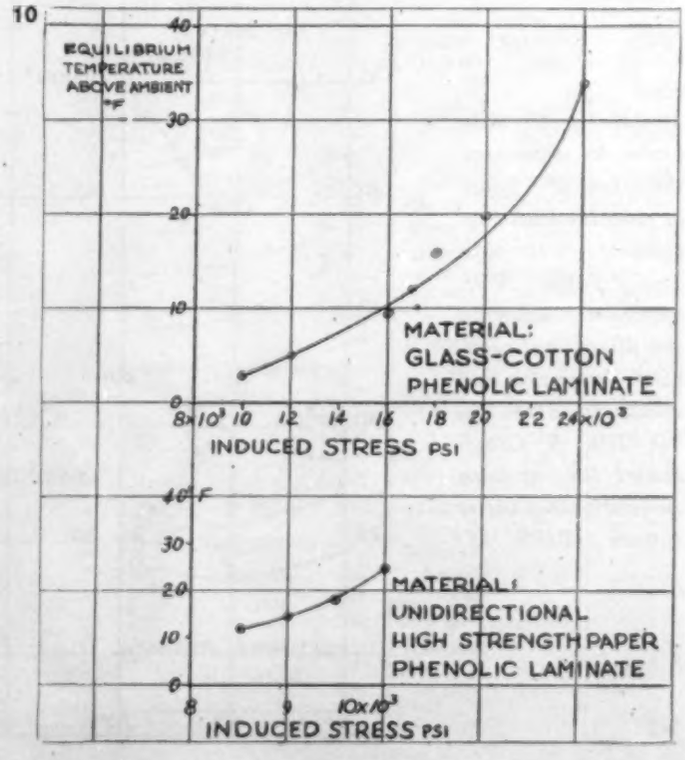
TABLE IX.—INCREASE IN DEFLECTION AFTER FATIGUE

Material →	*Deflection*			
Stress (p.s.i.) →	*P1*	*P4*	*A*	*L*
Cycles × 10⁴	*7000*	*8500*	*7500*	*7500*
	in.	*in.*	*in.*	*in.*
5	...	...	0.000	0.000
10	...	0.000	0.000	0.004
15	...	...	0.001	0.004
20	0.000	0.000	...	0.004
25	...	...	0.001	0.004
30	...	0.000	0.001	...
35	...	...	0.002	0.009
40	0.002	0.002	0.002	...
45	...	...	0.003	0.013
50	...	0.001	0.003	...
55	...	...	0.006	...
60	...	0.001	...	...
70	0.002	0.002	...	...
80	0.003	0.003	...	...
90	...	0.001	...	...
110	0.002	...	...	...
120	0.003	...	...	...
130	...	0.005	...	...
140	...	0.019	...	...
150	0.002	...	...	...
170	0.002	...	...	...
180	0.003	...	...	...
190	0.002	...	...	...
200	0.003	...	...	...

TABLE X.—SHEET FATIGUE TEST OF LAMINATES

Induced stress →	*Temperature rise above ambient*		*Cycles to produce failure × 10⁶*				
Material →	*G*	*P4*	*A*	*L*	*P1*	*P1'*	*P4*
p.s.i.	*° F.*	*° F.*					
6,000	..	..	2.0[a]	2.0[a]	...	...	...
6,500	..	..	1.7	..	...	...	...
7,000	..	..	0.90	1.6	2.0[a]	...	...
7,200	..	..	...	..	...	10.0[a]	...
7,500	..	..	0.55	0.35	...	...	...
7,900	..	..	...	..	...	2.0[a]	...
8,000	..	..	0.065	0.05	0.64	...	2.0[a]
8,500	..	11	...	..	...	...	1.25
8,600	..	..	...	..	...	0.6	...
9,000	..	15	...	..	0.165	...	0.90
9,500	..	19	...	..	...	...	0.37
	..	..	...	..	...	...	0.225
10,000	3	25	0.0047	..	...	0.18	0.10
11,000	..	..	...	..	0.027	...	...
12,000	5	..	0.0011	..	...	...	...
12,200	..	..	...	..	...	0.050	...
16,000	10	..	...	..	...	...	...
17,000	12	..	...	..	...	...	...
18,000	16	..	...	..	...	...	...
20,000	20	..	...	..	...	...	...
24,000	34	..	...	..	...	...	...

[a] Specimen did not fail; test discontinued.



that commercial phenolic laminates, grades X and C, have R.A. factors approximately one-tenth that of aluminum alloy.

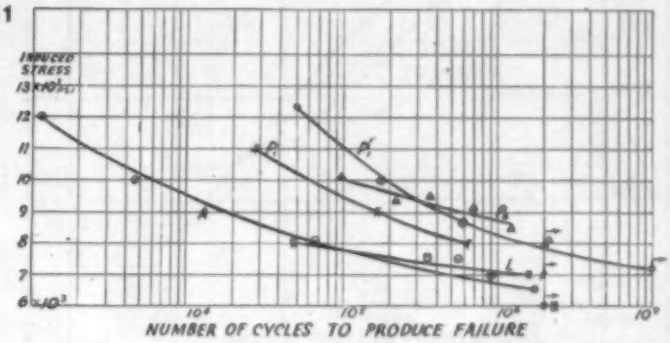
The high damping capacity of plastics results in an increase in temperature within the material. This effect is accentuated by the poor thermal conductivity which tends to retard thermal losses. Figure 10 shows the temperature rise of 2 materials when the specimen has come to thermal equilibrium at various stress levels. Considering the high-strength paper laminate, it is seen that at 9000 p.s.i. the equilibrium temperature is approximately 15° F. above ambient temperature. Data previously presented (Fig. 3) show that this increase in temperature will result in a reduction of flexural modulus of approximately 6½ percent. The actual stress in the fatigue specimen is therefore smaller than intended by at least an equal amount. There are other factors which tend to increase this deviation but the thermal effect is by far the greatest. Fatigue strength allowables determined without recognition of the above will be too high. They can be corrected as indicated, however, if the variation of modulus of elasticity with temperature is known.

The effect of temperature is further emphasized by tests reported recently by an aircraft manufacturer.[2] Laminated phenolic specimens (believed to be high-strength paper) were fatigue-tested at 10,000 p.s.i. Two specimens were tested as usual and 2 in a slipstream of air. The air produced a drop in surface temperature of 9° F. The cooled specimens required 280 percent more reversals to produce failure. Since airplanes are cooled by the slipstream in flight, it is concluded that fatigue strength determinations will result in conservative design. This is true if cognizance has been taken of the reduction in modulus discussed above, or if values are determined in a constant stress machine, such as that described by Lazan; otherwise, it is erroneous. Furthermore, airplanes required to operate at low altitudes in desert or tropical conditions may operate at temperatures above that at which fatigue strengths are ordinarily determined, and the effect noted in the above report will be on the dangerous, rather than on the safe side.

Figure 11 shows the S-N curves for 4 materials. Curves P1 and P1′ are cross-banded high-strength paper tested at different laboratories. Failure of P1 was determined by the deflection method, P1′ by first visible cracks. P4 is a unidirectional high-strength paper, "with grain." L is a commercial grade L laminate and A is a special felted asbestos.

Figure 12 shows S-N curves for cross-banded high-strength paper (P2) tested on a rotary-beam machine for notched and unnotched specimens. In the latter case the last 6 points, marked 0, were run at 10,000 r.p.m. while one point, marked

11



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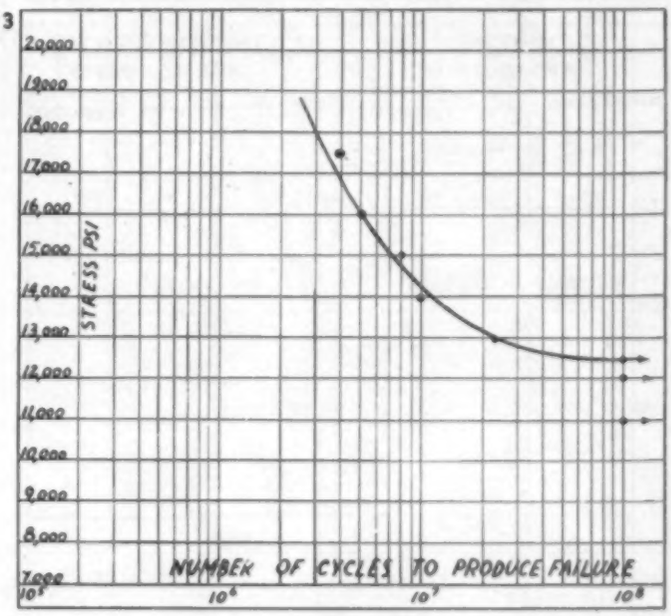
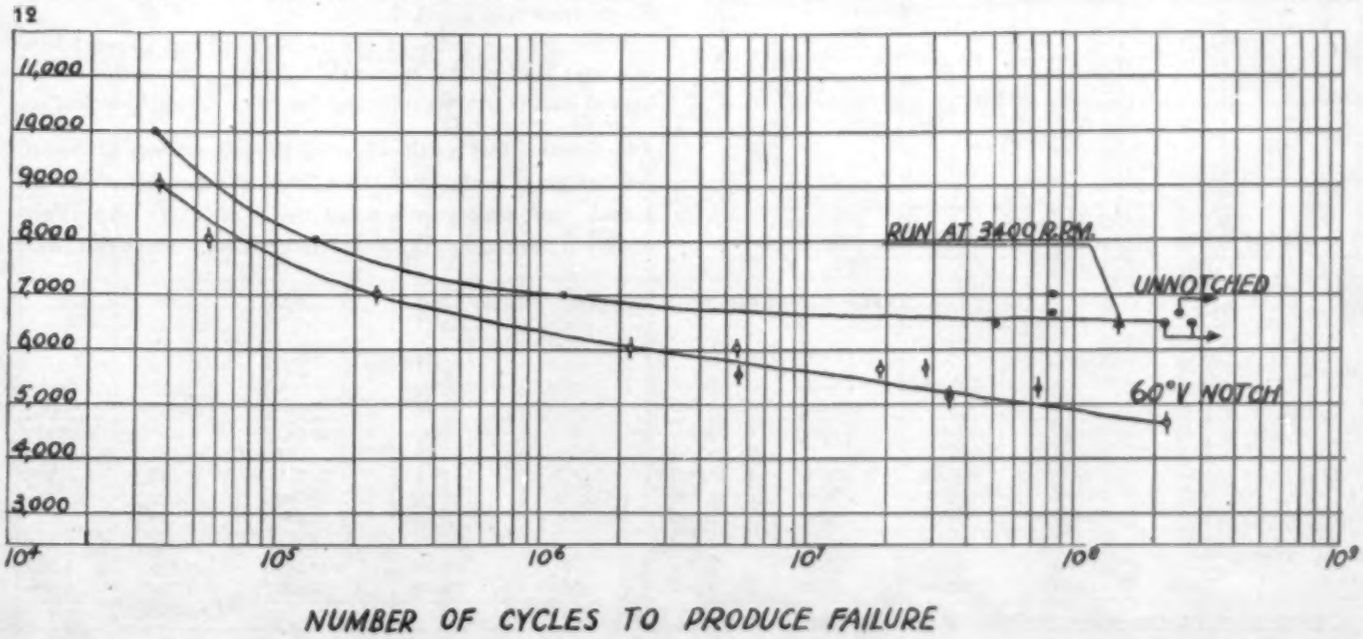
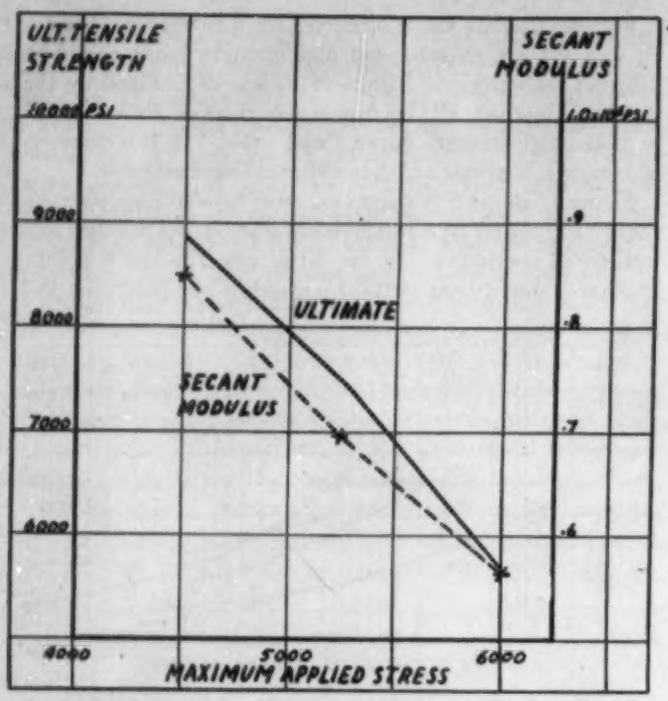


10—Graph of temperature rise during fatigue tests (see Table X). **11**—*Sheet fatigue strength of laminates (see Table X).* **12**—*Rotary-beam fatigue strength of high-strength paper laminate.* **13**—*Graph shows the sheet fatigue strength of unidirectional glass-cotton laminates*

12





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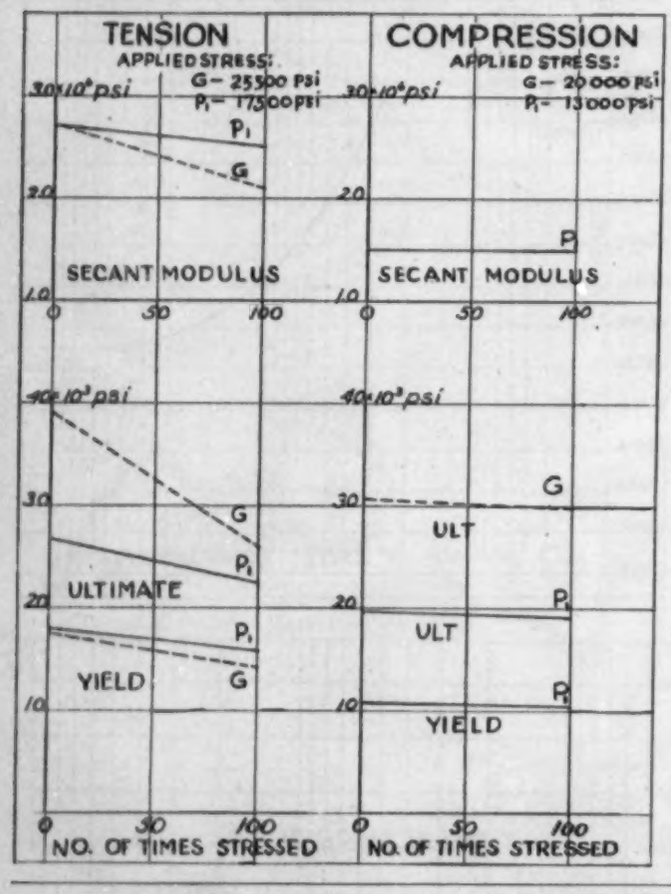


15

Δ, was run at 3400 r.p.m. The results indicate that values obtained at both speeds are comparable.

An S-N curve for sheet fatigue of unidirectional glass-cotton laminate is shown in Fig. 13.

The effect of repeated stresses

Data are available to show that certain plastic laminates deteriorate under the action of repeated tensile stresses. The nature of the failure produced by repeated stress is not known. However, at least 2 possible causes have been suggested: 1) brittle failure in the resin, producing sharp edges or particles which gradually destroy the reinforcing fibers; 2) poor adhesive bond between the resin and the reinforcing agent, especially in the case of glass. It is difficult to get the resin to wet the glass which is present in the material in the form of relatively short fibers. These depend principally on the resin for unification and for transfer of load from one fiber to another. Examination of the fracture of a tensile specimen broken by repeated stresses showed by its shredded appearance that the bond between the fibers is inadequate.

Tests were conducted on grade C material cut from an experimental antenna mast. One sample was stressed 30 times to 4500 p.s.i., another to 5250 p.s.i., after which the specimens were tested to ultimate. A third specimen, stressed to 6000 p.s.i., failed at 5695 p.s.i. after 27 applications of load. Other results obtained in these tests are shown in Fig. 14. Both the ultimate strength and the secant modulus decreased for increased repeated loads.

A second series of tests was conducted on high-strength paper and glass-fiber cotton laminate. Specimens were stressed repeatedly to approximately two-thirds of the expected ultimate after which they were broken. One specimen of each was stressed 50 times, another 100 times. This was done in compression and tension. The results are indicated in Fig. 15. The compressive properties were not adversely affected. In tension, however, the ultimate strength of the glass material decreased from 39,000 p.s.i. to 27,000 p.s.i. or 31 percent and the yield strength from 17,500 p.s.i. to 14,500 p.s.i. or 17 percent. Corresponding values for high-strength paper were 27,000 and 23,000 p.s.i. (ultimate), 17,500 and 16,500 p.s.i. (yield) or 15 and 6 percent, respectively.

A repeated bearing test, applying two-thirds the expected bearing strength 50 times, was run on high-strength paper material, after which the bearing strength was determined. No decrease was noted.

Work done recently at the Bell Telephone Laboratories[3] indicates that plastic materials fail under the action of repeated impact at energy values far below single blow impact

14—Graphic test results showing repeated stress of experimental mast material. 15—Effect of repeated stress on tensile and compressive properties (Table XI). 16—Variability of high-strength paper laminate is shown in this chart

TABLE XI.—EFFECT OF REPEATED STRESS

Material	Tension					Compression				
	No. of times stressed	Applied repeated stress[a]	Ultimate strength	Yield strength	Secant modulus	No. of times stressed	Applied repeated stress[a]	Ultimate strength	Yield strength	Secant modulus
		p.s.i.	p.s.i.	p.s.i.	p.s.i. × 10^3		p.s.i.	p.s.i.	p.s.i.	p.s.i. × 10^3
G	1	0	39,500	16,745	2.392	1	0	28,200	16,440	2.349
	51	26,000	35,900	18,200	2.600	51	12,000	29,300	...	...
	100	24,000	26,150	14,600	2.085	101	12,000	29,400	...	...
P1	1	0	25,050	13,355	1.909	1	0	19,375	10,795	1.542
	51	17,000	23,650	16,000	2.300	51	13,000	19,500	10,650	1.523
	101	17,000	22,500	20,500	2.930	101	13,250	19,300	9,720	1.390

[a] Magnitude of the stress applied the indicated number of times before testing to ultimate.

strengths. For commercial reinforced phenolics, the impact fatigue strength is about 50 percent of the single blow impact strength. No data for the impact fatigue strength of high-strength paper or glass are yet available.

It is considered very important to continue the investigation of the effect of repeated stresses on plastic materials. Recently, service failures have occurred in certain types of laminated phenolic antenna masts and other laminated parts

16

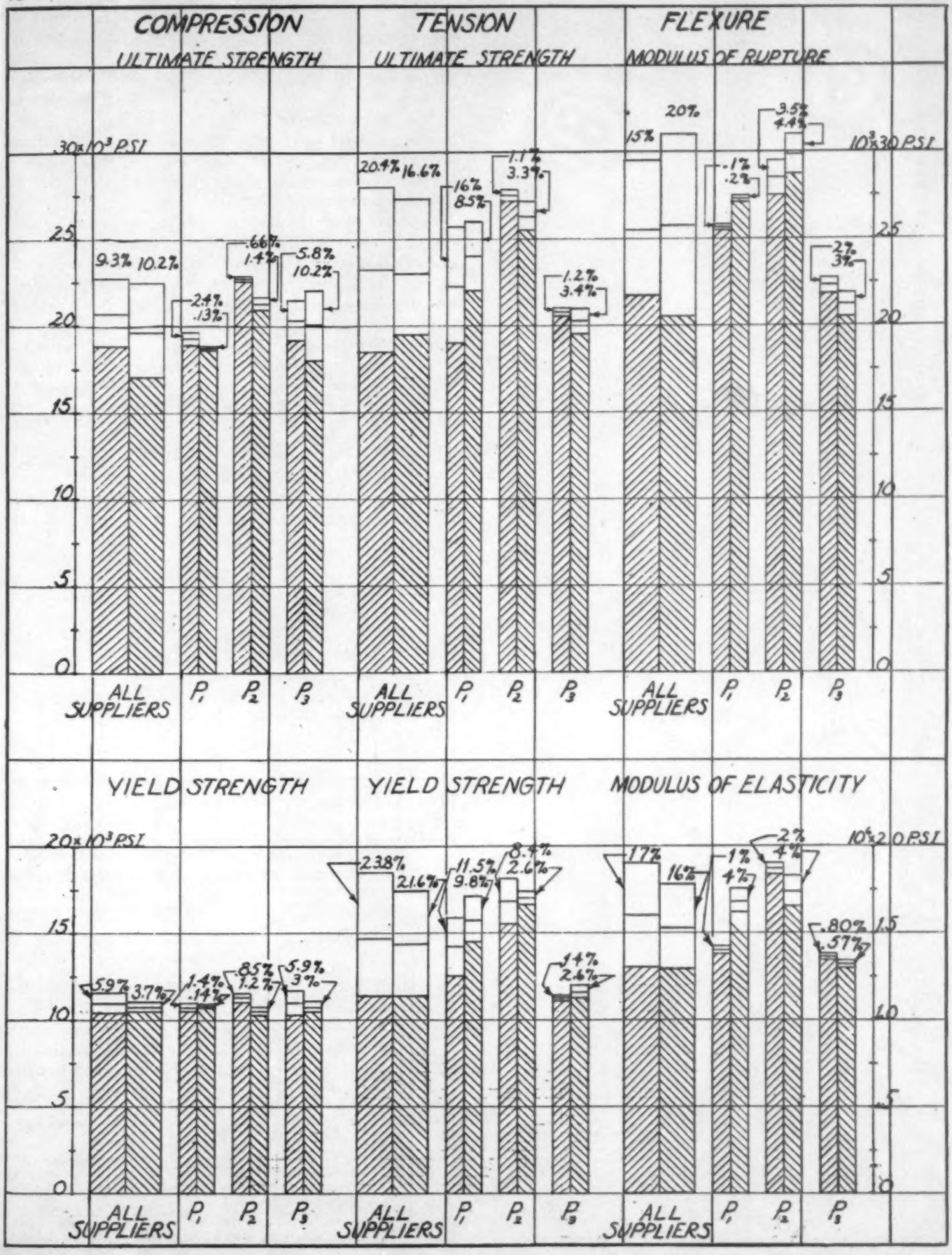


TABLE XII.—EFFECT OF MOLDING PRESSURE ON MOISTURE ABSORPTION, DIMENSIONAL STABILITY AND SPECIFIC GRAVITY OF KRAFT-PAPER PHENOLIC LAMINATE

(Data supplied by Continental-Diamond Fibre Co.)

Molding pressure	Resin content	Moisture absorption				Dimensional stability										Specific gravity
		Original weight	After 24 hr.	After 1 week	After 1 month	Thickness at edge			Thickness at center			Length			Width			
						Original	Change after 24 hr.	Change after 1 week	Original	Change after 24 hr.	Change after 1 week	Original	Change after 24 hr.	Change after 1 week	Original	Change after 24 hr.	Change after 1 week	
p.s.i.	%	gm.	%	%	%	in.	%	%	in.	%	%	in.	%	%	in.	%	%	
75	45	6.754	37.6	40.9	...	0.1334	20.35	20.00	0.1333	21.10	20.95	2.990	0.242	0.156	1.002	0.689	0.663	1.05
	55	8.274	5.85	14.20	20.30	0.1430	9.47	11.90	0.1430	4.11	10.65	2.989	0.050	0.150	1.007	0.254	0.596	1.23
150	35	7.885	10.74	19.83	24.20	0.1303	13.10	14.87	0.1361	8.18	14.88	2.989	0.035	0.042	1.006	0.447	0.597	1.18
	45	8.174	3.86	9.71	14.27	0.1227	6.89	11.78	0.1282	3.47	9.00	2.988	0.040	0.142	1.008	0.198	0.547	1.30
	55	8.306	2.84	7.90	11.49	0.1260	5.79	10.94	0.1257	2.35	6.60	2.990	0.018	0.100	0.998	0.135	0.500	1.35
500	35	8.852	4.95	12.71	17.16	0.1344	9.50	17.25	0.1348	4.63	13.15	2.990	0.038	−0.016	1.002	0.125	0.424	1.34
	45	8.853	3.19	8.90	12.88	0.1322	6.39	13.05	0.1324	3.10	8.27	2.989	0.025	0.050	1.000	0.160	0.500	1.38
	55	9.040	2.37	6.81	10.79	0.1359	4.79	10.50	0.1361	1.98	5.35	2.991	0.030	0.058	0.996	0.195	0.421	1.37
1200	35	8.686	4.73	12.91	16.27	0.1272	10.75	20.30	0.1272	5.27	15.15	2.990	0.022	−0.017	1.002	0.150	0.490	1.41
	45	8.626	3.34	9.28	13.11	0.1266	6.59	14.10	0.1265	3.32	9.28	2.989	0.030	0.043	0.996	0.155	0.451	1.40
	55	8.817	2.17	6.06	9.98	0.1318	4.37	10.02	0.1314	2.17	5.25	2.989	0.027	0.030	1.001	0.100	0.360	1.37

for military aircraft. The fact that the parts showed adequate strength in single load application tests points to repeated stress as the probable cause of the service failures.

The effect of molding pressure

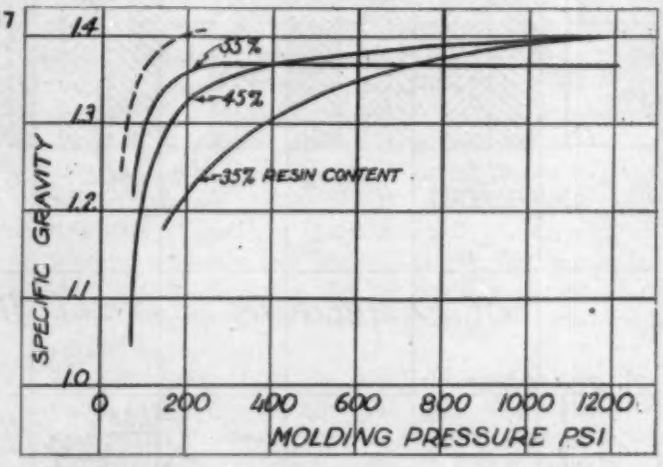
The last year has seen an intensification of the interest in low-pressure moldings. This has been prompted primarily by economic and technical considerations of production. When the proposal to develop low-pressure processes was first made to commercial laminators, they were reluctant to do so, and they stated that physical properties would suffer with decreased pressures. Nevertheless, low-pressure processes and laminates have of necessity been developed and there are beginning to be accumulated data on the relationship between physical properties and molding pressure.

Figure 17 shows the effect of molding pressure on specific gravity. The 3 solid lines represent a special kraft paper phenolic laminate, the resin content being indicated on each curve. The dotted curve represents a high-strength paper with a resin content of about 35 percent. With the exception of the kraft material of low resin content, it is seen that the specific gravity remains relatively constant as the pressure is reduced to 200 p.s.i., below which density decreases rapidly.

Figure 18 shows the variation in moisture absorption with molding pressure for the high- (*Please turn to page 126*)

17—*Specific gravity vs. molding pressure for high-strength (broken line) and kraft paper phenolic laminates (see Table XII).* **18**—*Moisture absorption vs. molding pressure for high-strength (broken line) and kraft paper phenolic laminates (Table XII)*

17



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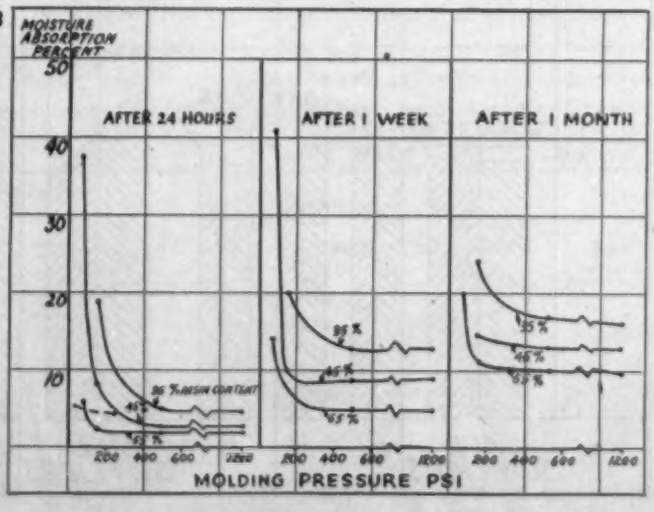

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VACUUM PUMPS for extracting venom from snake-bite wounds are now molded of Tenite plastic. Adopted by the Army Medical Corps for use in the tropics, these pumps perform under extreme conditions of heat and high humidity.

Tenite is lighter in weight than the metal it replaced. It has exceptional strength, will not dent or rust, is virtually indestructible. Close tolerances, so necessary for efficient operation of the vacuum pumps, are maintained with Tenite because of its excellent dimensional stability.

A prescribed material for many precision instruments, Tenite is used in retinoscopes, baumanometers, thermometers, X-ray equipment and hearing aids. For further information on the uses of Tenite, write to TENNESSEE EASTMAN CORPORATION (Subsidiary Eastman Kodak Company), KINGSPORT, TENN.

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Tenite snake-bite kit molded by Worcester Moulded Plastics Co. for Saunders Venom Extractor Co.

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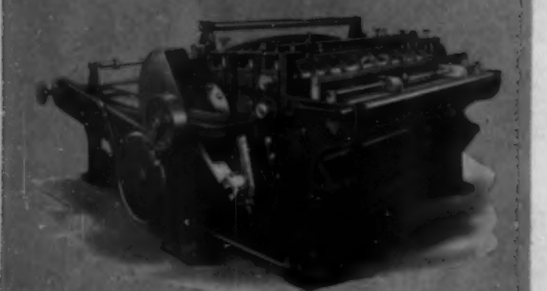
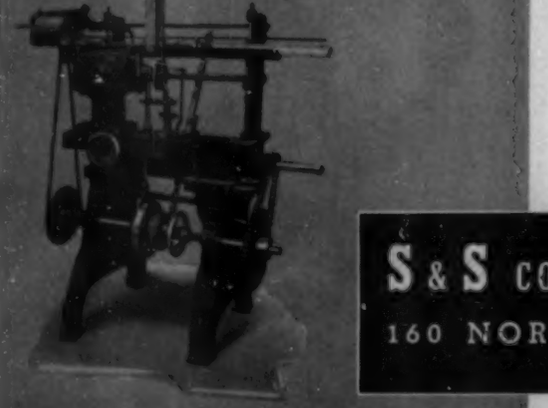


S&S GUILLOTINE SHEET CHOPPER



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Experience has shown that their use results in higher production, increased accuracy and less waste in material which all add up to one thing—lower costs and more profits.

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For trimming and cutting rolls of material to sheets from 0 to 55″ in length with $^1/_{32}$″ accuracy, and delivering finished product in uniform stacks.

The S & S Extruded Material Cut-Off Saw

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Plastics technical committees in the U. S.

THE organization and functions of the many technical committees and engineering groups in this country which are concerned with plastics were reviewed at a meeting held in Washington on June 21. The purpose of the meeting, which was sponsored jointly by the ANC Technical Subcommittee on Plastics and the ACCA Airplane Technical Committee, was to obtain information regarding the membership and activities of the various committees, to discuss coordination and dissemination of engineering data on plastics, and to outline plans for cooperation between the various groups. It is believed that many of the readers of Modern Plastics will be interested in the broad picture of the work of these committees that was obtained as a result of this survey. The committees are broken down into four groups for the purposes of this review: namely, plastics industry, aircraft industry, Government and technical societies.—G.M.K.

Plastics Industry Committees

NEMA Laminated Products Section Technical Committee

The Laminated Products Section of the National Electrical Manufacturers Association has a membership of 11 manufacturers of laminated plastics, as follows:

Continental-Diamond Fibre Co.
Formica Insulation Co.
General Electric Co.
Mica Insulator Co.
National Vulcanized Fibre Co.
Panelyte Corp.
Richardson Co.
Spaulding Fibre Co.
Synthane Corp.
Taylor Fibre Co.
Westinghouse Electric and Manufacturing Co.

Mr. R. R. Titus, Synthane Corp., is chairman of the Technical Committee, on which G. H. Mains, National Vulcanized Fibre Co. and other representatives of the company members serve as the need arises. Most contacts between this group and the Government are handled by the Plastics Industry Committee on Laminates organized jointly with the SPI. An especially noteworthy activity of the NEMA Laminated Products Section is the recent establishment of a research project at Johns Hopkins University to further the development of basic engineering data on the properties of laminated plastics.

Plastics Industry Committee on Laminates

This committee is composed of representatives of the NEMA Laminated Products Section, the Society of the Plastics Industry and laminators who are not members of either one of these groups but who make laminated plastic parts or are experimenting with them. The membership of the committee is as follows:

F. W. Warner, Plastics Dept., General Electric Co., *Chairman*
G. H. Clark, Formica Insulation Co., *Vice-Chairman*
O. E. Anderson, Westinghouse Elec. and Mfg. Co.
R. W. Barber, Panelyte Div., St. Regis Paper Co.
Powel Crosley III, Crosley Marine Co.
E. H. Dillehay, Richardson Co.
A. A. Glidden, Hood Rubber Co.
E. O. Hausmann, Continental-Diamond Fibre Co.
C. V. Jacobs, Taylor Fibre Co.
G. H. Mains, National Vulcanized Fibre Co.
Chas. Marschner, McDonnell Aircraft Corp.
H. V. Thaden, Thaden Engineering Co.
O. S. Tuttle, U. S. Plywood Corp.

This committee was organized to take care of projects involving the laminated industry that can best be handled as an industry rather than by working with individual companies.

PMMA Technical Committee

The Plastics Materials Manufacturers Association is composed of 18 companies, as follows:

American Cyanamid Co.
American Plastics Corp.
Bakelite Corp.
Catalin Corp.
Celanese Corp. of America
Dow Chemical Co.
E. I. du Pont de Nemours and Co., Inc.
Durite Plastics
Durez Plastics and Chemicals, Inc.
B. F. Goodrich Co., Plastics Materials Div.
Makalot Corp.
Marblette Corp.
Monsanto Chemical Co.
Nixon Nitration Works
Plaskon Div., Libbey-Owens-Ford Glass Co.
Reilly Tar and Chemical Co.
Rohm and Haas Co.
Tennessee Eastman Corp.

The objects of this Association are: to promote, in all lawful ways, the general welfare of the plastics industry; to cooperate with any agency of the Government with respect to defense, or for any other purpose; to increase the use of plastics in the arts and industries; to study ways and means for eliminating waste in production and distribution, and to promote safety; to encourage research and promote improvements in the quality of plastics.

The Technical Committee of the Plastics Materials Manufacturers Association has designated the following Subcommittee to represent it before the Government and industry committees concerned with aircraft:

H. W. Paine, E. I. du Pont de Nemours and Co., Inc.
J. H. Adams, Bakelite Corp.
C. J. Romieux, American Cyanamid Co.

This organization has undertaken the preparation of a Handbook of Data on Plastics which is expected to be available in printed form in the near future.

SPI Technical Committee

The Society of the Plastics Industry is an organization of about 285 company members who are engaged in the manufacture, molding or fabricating of plastics, building machinery for the industry, or in other ways directly concerned with plastic materials. The Society functions in the following fields for its members:

Government regulations
Collection and dissemination of information and statistics
Collection of data on wage rates and generally on labor relations
Standardization programs under the auspices of the National Bureau of Standards
Maintains technical organization to prepare engineering data on plastics.

The SPI Technical Committee for 1943–44 is under the general chairmanship of W. J. McCortney, Chrysler Corp., with N. J. Rakas, Chrysler Corp., as alternate, and F. W. Warner, General Electric Co., as Vice-Chairman. The Technical Committee is divided into three divisions with membership as follows:

Thermosetting Division

R. A. Berg, Tech-Art Plastics Co., *Chairman*
K. Perkins, Diehl Manufacturing Co.
H. H. Wanders, Northern Industrial Chemical Co.
W. H. Randall, Keyes Fibre Co.
G. W. Carlson, Arrow-Hart and Hegemen Electric Co.
R. E. Larson, National Lock Co.

(Please turn to next page)

G. Koch, Victor Metal Products Corp.
G. W. Clark, Owens Illinois Glass Co.
B. F. Hantz, American Insulator Corp.
W. Dunnican, Reilly Tar and Chemical Co.
W. O. Gebhardt, Delco-Remy Co.
A. L. Alves, Watertown Manufacturing Co.
R. B. Barnes, American Cyanamid Co.
H. P. Koenneke, Joseph Stokes Rubber Co.
A. W. Koon, Columbian Rope Co.
F. R. McLaughlan, Makalot Corp.
F. H. Shaw, Shaw Insulator Co.
C. H. Whitlock, Monsanto Chemical Co.
W. A. Zinsow, Bakelite Corp.
C. Smith, Bryant Electric Co.

Thermoplastic Division

G. M. Kuettel, E. I. du Pont de Nemours and Co., Inc., *Chairman*
W. E. Gloor, Hercules Powder Co.
W. Lester, Pyro Plastics Co.
A. P. Marr, Gemloid Corp.
B. Bowlus, National Organ Supply Co.
D. Dillon, Dillon-Beck Manufacturing Co.
P. J. Graham, Worcester Moulded Plastics Co.
E. E. Mills, Elmer E. Mills Corp.
L. L. Berry, Erie Resistor Corp.
B. Andersen, Celanese Corporation of America
W. C. Goggin, Dow Chemical Co.
E. W. Halbach, Bolta Co.
J. C. Kasimier, Chicago Molded Products Corp.
L. L. Merrill, Carbide and Carbon Chemicals Corp.
L. W. A. Meyer, Tennessee Eastman Corp.
G. Schmitter, Nixon Nitration Works, Inc.
E. T. Weibel, Irvington Varnish and Insulator Co.
S. L. Brous, B. F. Goodrich Co.

Resin Adhesive Division

R. E. Dodd, Durez Plastics and Chemicals, Inc., *Chairman*
R. Casselman, Bakelite Corp.
A. F. Draper, Langley Aircraft Corp.
C. B. Hemming, U. S. Plywood Corp.
C. L. Jones, Monsanto Chemical Co.
N. G. Maloney, Allied Aviation Corp.
J. G. Nelson, General Electric Co.
T. D. Perry, Resinous Products and Chemicals Co.
E. C. Pitman, E. I. du Pont de Nemours and Co., Inc.
H. Rawden, Beech Aircraft Corp.
J. M. Stevens, Fairchild Co.
H. V. Thaden, Thaden Engineering Co.
J. H. Tigelaar, Haskelite Corp.
C. F. Van Epps, I. F. Laucks, Inc.

The work of the SPI Technical Committee is now largely with the military services, particularly the Naval Observatory, the Quartermaster Corps, Army Ordnance Department and the Signal Corps. Additional activities include:

Preparation and distribution of engineering data on plastics
Standardization of dimensions and tolerances of molded parts
Preparation of materials for particular applications
Standardizations of molding techniques wherever necessary.

The Technical Committee has prepared and published two bulletins as follows: "Extruded Plastic Tubing and Shapes"; "Manual on Assembly Gluing."

In concluding this review of the technical committees of the plastics industry, it should be noted that steps have been taken to organize an "Executive Committee of the Plastics Industry" to further coordinate the work of the various committees and to represent the industry in contacts with the Government and aircraft industry committees. This Executive Committee consists of C. J. Romieux, American Cyanamid Co., representing PMMA, Chairman; G. H. Clark, Formica Insulation Co., representing NEMA Laminated Products Section; and N. J. Rakas, Chrysler Corp., representing SPI.

Aircraft Industry Committees

ATC Plastics Subcommittee

The Aeronautical Chamber of Commerce of America, comprised of manufacturers of aircraft, has an Airplane Technical Committee to study problems of a non-competitive nature dealing with aircraft structural and aerodynamic requirements, to coordinate industry opinion on specific problems, and to submit recommendations to the pertinent Government agencies for the promulgation or revision of Government standards, specifications and design requirements. Technical Subcommittees of the Airplane Technical Committee are formed to cooperate with parallel subcommittees of the ANC Committee on Aircraft Design Criteria. The ATC Plastics Subcommittee is one such group, composed of 32 technical representatives who have been appointed by their respective companies to act on all problems relating to plastics, as follows:

N. G. Maloney, Allied Aviation Corp.
M. A. Chester, Beech Aircraft Corp.
H. R. Leader, Bell Aircraft Corp.
L. M. Perdue, Boeing Aircraft Co.
C. B. Barlow, Boeing Aircraft Co.
B. L. Manire, Boeing Aircraft Co.
C. C. Covucci, Brewster Aeronautical Corp.
H. E. Johnson, Edward G. Budd Manufacturing Co.
B. Epstein, Chance Vought Aircraft Div. of United Aircraft Corp.
H. Rosenbaum, Consolidated Vultee Aircraft Corp.
G. W. O'Hare, Consolidated Vultee Aircraft Corp.
R. B. Stringfield, Consolidated Vultee Aircraft Corp.
C. M. Jamieson, Culver Aircraft Corp.
A. F. Donovan, Curtiss-Wright Corp.
L. P. Wood, Curtiss-Wright Corp.
E. S. Harrar, Curtiss-Wright Corp.
E. P. Burton, Douglas Aircraft Co., Inc.
F. J. Krieger, Douglas Aircraft Co., Inc.
E. H. Heinemann, Douglas Aircraft Co., Inc.
L. L. Hanson, Fleetwings, Inc.
P. Thomas, G. and A. Aircraft, Inc.
J. A. Ashkouti, Grumman Aircraft Engineering Corp.
L. R. Cleaver, Interstate Aircraft and Engineering Corp.
W. H. Colcord, Kellett Autogiro Corp.
R. Contini, Langley Aviation Corp.
C. W. Armstrong, Lockheed Aircraft Corp.
W. A. Safka, Glenn L. Martin Co.
D. McCalla, McDonnell Aircraft Corp.
W. I. Beach, North American Aviation, Inc.
T. Piper, Northrop Aircraft, Inc.
R. G. Bowman, Republic Aviation Corp.
W. Otey, Ryan Aeronautical Co.
O. E. Brown, Vega Aircraft Corp.

The ATC Plastics Subcommittee will investigate the possibilities and promote the use of plastics in aircraft in both structural and non-structural applications when such use proves more efficient than other materials. It will study controversial items of a non-competitive nature which come up from time to time with a view toward obtaining a coordinated aircraft industry opinion. As a result of these studies, recommendations may be made to revise existing Government specifications, acceptance test procedures, and design allowances for plastic materials; suggestions may be made for improved types of plastics and their intended applications. Such studies will also provide an opportunity to bring to light any fabrication difficulties, service problems or undesirable physical properties of plastic materials being used in specific applications. Official contacts and correspondence for the Subcommittee will be handled by the Technical Department of the Aeronautical Chamber of Commerce of America through I. C. Peterson, Secretary of the ACCA Airplane Technical Committee.

The work of the ATC Plastics Subcommittee will be carried on by means of correspondence. The large membership together with the great distances between locations of member companies makes it both inadvisable and inconvenient to schedule meetings of the entire group. A four-man Steering Committee, comprised of the representatives from the Martin, Boeing, Lockheed and Consolidated Vultee companies, has been appointed to represent the ATC Plastics Subcommittee in dealing directly with the plastics committees of the Government agencies and plastics industry.

National Aircraft Standards Committee

This Committee also operates as part of the Technical Department of the Aeronautical Chamber of Commerce of America. It consists of a group which has been designated by the War Production Board as officially representing the aircraft industry on all matters relating to airframe standards work. Its functions are to study standards problems of a (*Please turn to page 144*)

NO COFFEE SHORTAGE HERE
. . . and this is why
Heat-sealed packets, made of aluminum foil combined with plastics, safeguard soluble coffee in "K" Rations supplied to our armed forces.
Coffee Product
Dissolve in 1½ canteen cup hot or cold water. Stir well.
Packaged by Miles Laboratories, Inc.

Here's another case where aluminum and plastics are working together to do a difficult job well—

Aluminum foil is laminated with acetate film on one side and coated on the other with a thermoplastic adhesive. Two ribbons of this material are fed into a machine which fills, heat-seals and trims off the "K" Ration coffee packet. In all climates, the coffee is kept from caking, losing strength or aroma.

The acetate film gives the aluminum extra toughness. The thermoplastic adhesive seals the package. The combination of aluminum and plastic produces a finished package that is completely airtight, moistureproof, vaporproof, verminproof and lightproof. No loss of freshness, flavor, aroma or color.

Imagineers are already planning how they can use such aluminum-and-plastic bags and envelopes for all sorts of postwar jobs. Others are letting their imagination dwell on new uses of aluminum and plastics in combination, and then engineering them into practical form. Perhaps we can help make your Imagineering practical. ALUMINUM COMPANY OF AMERICA, 2175 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

RECLAIMING POROUS CASTINGS. W. Bowman. Iron Age *151*, 52–3 (Apr. 8, 1943). The use of two phenolic varnishes in reclaiming castings rejected because of their porosity is described. One method of using these materials consists of placing the casting in a vacuum chamber, evacuating, running in the resin solution and then applying pressure. On removal from the chamber, the casting is baked at a low temperature, 85° C., to remove solvents and then at a higher temperature, 100° C. to 135° C., to cure the resin. Another method consists of placing the resin solution inside the casting and applying pressure to force the solution into the pores. In cases of severe porosity, two treatments with intervening baking may be used. A clear solution of a special resin and a solution of resin containing finely divided mineral filler are used. The methods have been tried in plant practice and found to be satisfactory.

COAL BY-PRODUCTS IN THE PLASTICS INDUSTRY. R. L. Wakeman. Blast Furnace Steel Plant *31*, 217–9, 320–2 (Feb., Mar. 1943). Coal as a source of chemicals for the synthesis of plastics is discussed. The chemicals produced from coal and used in the plastics industry are phenols, naphthalene, benzene, coumarone, indene and coke. The phenols are used to make phenolic resins and nylon (by way of adipic acid and hexamethylene diamine). Naphthalene is converted to phthalic anhydride for use in alkyd resins. Coumarone and indene are used to make resins. Benzene is converted to styrene for use in the production of polystyrene and synthetic rubber. Derivatives of these chemicals produced from coal are also used in the manufacture of plasticizers. Coke is a basic material for the production of many organic chemicals such as urea, melamine and vinyl compounds.

DERMATITIS FROM NEW SYNTHETIC RESIN FABRIC FINISHES. L. Schwartz. Rayon Textile Monthly *24*, 309–10 (June 1943). Many cases of dermatitis have been traced to synthetic resin fabric finishes. The causes of some cases of dermatitis have been traced to 1) an acid ester gum finish, 2) formaldehyde from urea-formaldehyde resin finish, 3) alkalis used to make resin emulsions, 4) maleic anhydride, succinic anhydride and diethylene glycol from alkyd resins, 5) solvents such as alcohol or cellosolve and 6) dicyandiamide-formaldehyde resins. Test methods are described.

Chemistry

PREPARATION OF ALLYL AND METHALLYL METHACRYLATES. C. E. Rehberg, C. H. Fisher and L. T. Smith. J. Am. Chem. Soc. *65*, 1003–6 (June 1943). Methods are reported for preparing allyl and methallyl α-hydroxyisobutyrates from hydroxyisobutyric acid and the appropriate alcohol. The hydroxy esters were converted into allyl and methallyl α-acetoxyisobutyrates by treatment with acetic anhydride. Under milder conditions than those required for the thermal decomposition of the corresponding acetoxypropionates, allyl and methallyl acetoxyisobutyrates were transformed satisfactorily by pyrolysis into allyl and methallyl methacrylates.

ADVANCES IN THE FIELD OF PLASTICIZERS. W. M. Münzinger. Kunststoffe *31*, 389–95 (1941). The properties of many new plasticizers are listed. Soft polymers, such as polyacrylic esters, are used as plasticizers. Water-insoluble materials, such as tricresyl phosphate, are used as plasticizers in aqueous dispersions of resins.

Properties

CALCULATION OF THE COLOUR OF PIGMENTED PLASTICS. J. L. Saunderson. J. Opt. Soc. Amer. *32*, 727–36 (Dec. 1942). Assuming that the optical properties of a pigment can be described by two constants only, that is, the absorption and the scattering coefficients, it is shown that it is possible to develop a simple method for determining the optical constants of mixtures of dyes and pigments and so to calculate the color of any specified pigment mixture. The use of the method to give the composition of the mixture needed for a color match with a given sample is explained.

INVESTIGATION OF THE MECHANICAL BEHAVIOR OF SYNTHETIC RESINS AT LOW TEMPERATURES AND ITS DEPENDENCE UPON PREPARATION AND PRETREATMENT. W. Röhrs and K. H. Hauck. Kunststoffe-Tech. u. Kunststoffe-Anwend. *11*, 213–28 (1941). The modulus of elasticity in compression and the elastic limit of thermosetting and thermoplastic resins at 20° to −70°C. were measured. With phenolic resins, the modulus of elasticity and the elastic limit increases with an increase in the degree of cure; the plastic deformation decreases. The weight, volume and amount of free phenol decrease with an increase in cure. The coefficient of thermal expansion can also be used as a measure of the degree of cure. The mechanical properties of thermoplastics are more dependent on temperature than are those of thermosetting resins. The method of polymerization also affects the mechanical properties of the resin.

THE EFFECT OF SURROUNDING MEDIUM ON THE DIELECTRIC STRENGTH OF LAC AND LAC MOLDED MATERIALS. G. N. Bhattacharya. Indian J. Phys. *16*, 261–70 (1942). The dielectric strengths of several lac molding compounds were measured in transformer oil, xylene, kerosene, turpentine, castor oil and a mixture of xylene and acetone. The dielectric strength increased as the specific resistance of the media decreased.

Testing

VARIABLES AND SUGGESTED MODIFICATIONS IN ACCELERATED LIGHT AGING. C. K. Chatten and T. A. Werkenthin. India Rubber World *108*, 40–2 (Apr. 1943). The various factors affecting the accelerated aging of rubbers in a carbon arc apparatus are discussed. The results of temperature and light intensity measurements made during the tests are reported. It is recommended that the specimens be mounted at an angle instead of vertically. The test procedure should be standardized as to 1) maximum and minimum temperatures, 2) thickness and surface conditions of the specimens and 3) temperature, volume and purity of the water spray.

TESTING PROCEDURES FOR PLASTICS WHICH REPLACE RUBBER, GUTTA-PERCHA AND LEAD. Paul Nowak and Wilhelm Esch. Kunststoffe *31*, 401–3 (1941). Plasticizers for polyvinyl chloride are evaluated by testing 1) the plasticizer alone and 2) the plasticizer mixed with polyvinyl chloride. The plasticizers are tested for appearance, density, viscosity, boiling range, acid number, pH of aqueous extract and rate of evaporation on heating. The plasticized polyvinyl chlorides are tested for loss of weight and strength properties at low temperatures. Data on butadiene copolymers are also given. An apparatus for determining the abrasion resistance of insulated cable is described.

TESTING ELASTICITY OF SYNTHETIC RUBBERS AT LOW TEMPERATURES. G. D. Kish. Aero Digest *42*, 245–6, 257, 339 (May 1943). A device, called the Elastensometer, for determining the elasticity of rubberlike materials is described. The apparatus is suitable for making measurements at low, ordinary and elevated temperatures. Force-temperature curves are obtained for a given deflection. When the force required to produce a constant deflection increases rapidly with small decreases in temperature, the critical limit of normal elastic properties has been reached.

FOR DIE-HOBBING

Southwark Hydraulic Presses

Close control, smoothness in power application and rugged dependability are built-in features of Southwark hydraulic presses. These qualities are indispensable for accurate die-hobbing.

Sound design, good materials and honest workmanship are part of every Southwark press. Southwark's years of press building experience are paying real dividends to the leaders in the plastics industry now that uninterrupted production is all-important.

When you're planning new plant equipment for the competition of tomorrow it will pay you to specify Southwark.

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PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

PLASTIC COATINGS IN THE POST-WAR ERA. J. B. Cleaveland. Textile World *93*, 59–64 (May 1943). The commercial organic plastics are discussed from the viewpoint of coatings for textile fabrics. The properties which should be important in postwar applications are emphasized. A table is given in which the solubility, compatibility, water resistance, acid resistance, alkali resistance, alcohol resistance, gasoline resistance, flammability resistance, heat resistance, cold resistance, sunlight resistance, tack resistance, flexibility, adhesion, heat-sealing ability, abrasion resistance, color, odor and price range of 17 plastics are compared qualitatively.

PLASTICS AND THEIR APPLICATION TO AIRCRAFT CONSTRUCTION. J. T. Zhibitsky. J. Royal Aeronautical Soc. *47*, 138–43 (May 1943). This is an English translation of an article which was printed in the Jan. 1941 issue of Aviation Industry, U.S.S.R. Many of the types of plastics used in Russia, their applications and properties are described. Phenolic plastics are apparently the most widely used in that country. Various applications of plastics in aircraft construction in Great Britain and U.S.A. are described. In Russia, plastics have been used comparatively little in the construction of aircraft, being limited chiefly to controls, instruments and cockpit window frames. This constitutes a fraction of one percent of the whole aircraft mass.

HEAT SEALING TECHNIQUES AND MECHANICS. F. S. Leinbach. Modern Packaging *16*, 91–4, 116 (June 1943). The effectiveness with which two or more layers of a particular heat-sealing material may be made to seal together depends upon three factors: 1) temperature; 2) pressure; 3) time. The interrelationships between these three factors in commercial heat-sealing operations are discussed.

Materials

PARACON—A NEW POLYESTER RUBBER. B. S. Biggs and C. S. Fuller. Chem. & Eng. News *21*, 962–3 (June 25, 1943). A polyester rubber-like material, made by the condensation of dibasic acids with glycols or by the condensation of hydroxy acids, is described. Properly compounded stock averages 1700 p.s.i. in tensile strength although experimental samples have been made with tensile strengths as high as 3000 p.s.i. The elongation at break averages 400 percent but may run as high as 600 percent. The material is oil-resistant, heat-resistant, light-resistant and odorless, and has a low brittle point and a fast curing cycle. It has relatively low resistance to alkaline and acid solutions and to steam.

RECENT DEVELOPMENTS IN ORGANIC PLASTICS FOR ELECTRICAL INSULATION. T. Hazen. Elec. Eng. *62*, 191–7 (May 1943). The electrical properties of phenolic and urea resins, phenolic resin varnishes, polystyrene, chlorinated diphenyl oxides and the vinyl resins are discussed in relation to electrical insulation problems. Curves are given which show the dielectric loss factor, the dielectric constant and the dielectric power factor for the various materials over a range of temperatures.

THE SECOND MILE. L. B. Sebrell. Ind. and Eng. Chem. *35*, 736–50 (July 1943). The properties of natural rubber are compared with those of butadiene-styrene copolymers, butadiene-acrylonitrile copolymers and butyl rubber. The properties considered are x-ray structure, molecular weight, electrical, resilience, tensile strength, elongation, aging characteristics, rebound, tear resistance, abrasion resistance, flex life, brittle point, extrusion and solvent resistance. Synthetic rubber has some serious deficiencies, particularly in its ability to give satisfactory results in pure gum stocks or good tensile strengths at elevated temperatures. To improve synthetic rubber, cross linkages must be removed to as great an extent as possible. Butyl rubber is inferior in several respects to the other synthetics and it excels them in other respects. Since butyl rubber is generally assumed to be more nearly a straight-chain polymer, further development along this line would seem to be in order by a radical change in the method of forming the rubber-like polymer.

Applications

PURIFIED MINERAL - FREE WATER FOR PHARMACEUTICAL PURPOSES. J. W. E. Harrisson, R. J. Myers and D. S. Herr. J. Am. Pharmaceutical Assoc., Sci. Ed. *32*, 121–8 (May 1943). Advances in the production of resin exchange absorbents have made possible the preparation by filtration procedures of mineral-free water equal in quality to that required for distilled water of the U.S.P. Ease of manipulation, low initial cost and freedom from costly maintenance recommend this method for preparing water for many pharmaceutical uses.

POLYVINYL ACETATE ADHESIVES. E. E. Halls. Plastics *7*, 189–93 (May 1943). Concentrated polyvinyl acetate solutions proved to be suitable for bonding phenolic laminate to itself and to paper, plywood to plywood and bituminized asbestos board to itself. Little or no deterioration occurred with these under fluctuating humidity and temperature conditions, but their resistance to water immersion was relatively poor.

CELLULOSE ACETATE SHEET PLASTIC ASSUMES IMPORTANCE FOR AIRCRAFT. W. E. Moeller. Aero Digest *42*, 183, 187, 191 (May 1943). Directions for forming, cleaning and polishing and handling transparent cellulose acetate sheets in canopy covers, portholes, escape hatches and other aircraft parts are presented.

Coatings

THE DEVELOPMENT OF THE HOT SPRAYING OF POWDERED MATERIALS. W. E. Ballard. Chem. & Ind. *62*, 190–4 (May 22, 1943). The development of the hot spraying of powdered materials is traced from the basic patent of Schoop in 1911 through the Schori gun to a recent patent issued to the I.C.I. in England for spraying polyethylenes. Various designs of guns are described and illustrated. In hot spraying plastics the powder feed rate should be high and the flame volume low. The initial deposited film should be in a partially plasticized form—that is, with half the particles melted and the other half unmelted. Once this partial coating is established, heat is applied to the surface to get a smooth continuous coating. Coatings applied in this manner contain no solvent and if properly prepared are free of pinholes.

THERMAL EXPANSION OF PAINT FILMS. W. König. Kunststoffe-Tech. und Kunststoffe-Anwendung *11*, No. 6, 165–70 (1941). The thermal expansion of various paint films between −20° and 100° C. was measured. The measurements were made on films by a microscopic technique. The coefficients of thermal expansion were constant at low temperatures but increased steadily with rising temperatures. The average coefficients of thermal expansion of the films at low temperatures were many times those of metals. This results in the production of mechanical stresses when the temperatures of painted metals are changed. In films that are brittle (a characteristic of most paint films at low temperatures) these stresses may be sufficient to cause peeling. The stresses produced on cooling films on iron were measured by an optical strain method. The results were in agreement with those calculated from thermal expansion data.

HPM UPWARD ACTING TYPE—Self-contained platen presses. Open rod construction, equipped with one or more hot plates, according to requirements. H-P-M HYDRO-POWER radial pump, oil pressure operating system.

SIZES

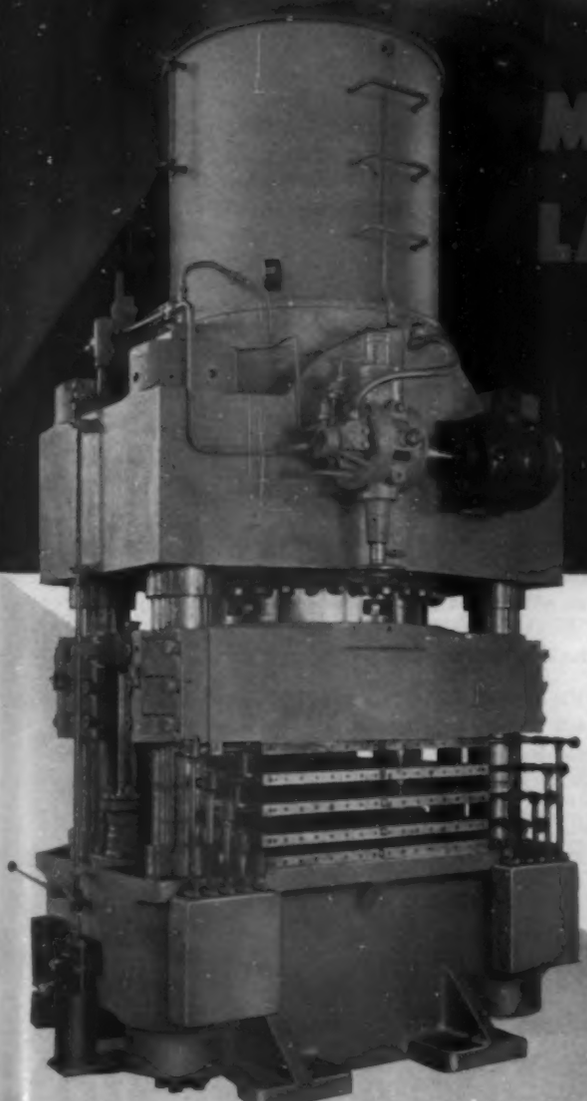
Tons	50	100	150	200	300	500
Hot Plate Size	18"x18"	24"x18"	24"x24"	30"x24"	36"x30"	36"x36"
Ram Travel	12"	12"	12"	12"	18"	18"
Motor (HP)	3	3	3	3	7½	7½

Note: Daylight opening between plates, and number of plates according to requirements. Larger size presses built on special order.

H-P-M Hot Plate Presses

FOR THE MASS PRODUCTION OF LAMINATED PLASTIC MATERIALS

Presses can be furnished without hot plates, if used in connection with high frequency electrostatic heating equipment.



HPM DOWNWARD ACTING TYPE—Self-contained Fastraverse platen presses equipped with one or more hot plates, according to requirements. Fastraverse radial pump, oil pressure operating system.

SIZES: Pressure ratings — 50 to 5000 tons. Platen sizes in 12" increments. Ram Travel in 6" increments. Daylight Openings between plates, according to requirements.

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U. S. Plastics Patents

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ARTIFICIAL GLASS. I. E. Muskat, M. A. Pollack, F. Strain and W. A. Franta (to Pittsburgh Plate Glass Co.). U. S. 2,320,533, June 1. A transparent, rigid, thermoplastic sheet is surfaced with a film of substantially infusible, insoluble polymer of an ester containing at least two unsaturated groups derived from an acrylic or alpha-substituted acrylic acid.

METHOD OF COATING. M. A. Pollack, F. Strain and I. E. Muskat (to Pittsburgh Plate Glass Co.). U. S. 2,320,536, June 1. A compound having at least two polymerizable unsaturated groups separated by at least one oxygen linkage is partially polymerized, dissolved in a suitable solvent, applied in a continuous film to a sheet of thermoplastic resin, dried by evaporating the solvent, and finally completely polymerized by heating between smooth surfaces in the presence of organic peroxides.

COFFEE RESIN. H. S. Polin. U. S. 2,320,649, June 1. Plastic comprising a small percentage of rubber and a larger percentage of moldable resin obtained by treatment of coffee beans under heat and pressure.

STYRENE RESINS. H. L. Gerhart and W. W. Bauer (to Pittsburgh Plate Glass Co.). U. S. 2,320,724, June 1. Styrene is treated with alpha, beta unsaturated ethylene, alpha, beta unsaturated dicarboxylic acids and anhydrides of the acids giving resins containing the carboxylic groups of the acids, which are then partially esterified with a monohydroxy alcohol and a fatty acid.

ROSIN POLYMERS. O. A. Pickett (to Hercules Powder Co.). U. S. 2,320,795, June 1. Rosin and rosin esters are treated between 50° and 275° C. with a polymerizing agent comprising a mono alkali salt of sulfuric or phosphoric acid.

NEW RESINS. G. F. D'Alelio (to General Electric Co.). U. S. 2,320,816-7-8-9-20, June 1. Condensation products of a fusible aminoplast and a halogenated nitrile, an amidogen compound, an aldehyde and a polysalicylide, an aminotriazine, an aldehyde and at least one halogenated nitrile, an aldehyde and a bis-diamino triazinyl, disulfide and an aminotriazole, an aldehyde and an halogenated nitrile.

TRANSLUCENT PLASTICS. W. H. Gift (to Rohm and Haas Co.). U. S. 2,320,924, June 1. Polystyrene, polyvinyl acetate and a polyacrylate are mixed and cast to give a uniformly translucent object.

ARTIFICIAL LEATHER. P. L. Salzberg (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,321,047, June 8. A sheet of a synthetic linear polyamide is cold worked at a temperature below 50° C. to an elongation of 50 to 200 percent and then subjected to mechanical pressure and heat above 60° C. but below the melting point of the polymer.

OPALESCENT RESINS. C. E. Schildknecht (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,321,048, June 8. An opalescent resin resulting from the polymerization of a mixture of polymethyl methacryiate, styrene monomer and a monomer of methyl methacrylate, methyl acrylate, *n*-butyl methacrylate or vinyl acetate.

CELLULOSE DERIVATIVES. H. Dreyfus (to Celanese Corp. of America). U. S. 2,321,069, June 8. An organic ester or ether of cellulose, in which the substituent radicle contains an ethylene linkage, is reacted with a bisulfite in the presence of heat.

SYNTHETIC FLEECE. G. Schneider (to Celanese Corp. of America). U. S. 2,321,108, June 8. Fibers of cotton are held together in a fleece-like web by a plasticized thermoplastic cellulose derivative.

UREA-FORMALDEHYDE COMPOSITION. A. M. Howald (to Libbey-Owens-Ford Glass Co.). U. S. 2,321,208, June 8. An anhydrous solution of urea-formaldehyde reaction product and an acid in an alcohol.

UREA-FORMALDEHYDE COMPOSITION. J. A. Murray and A. W. Kassay (to Libbey-Owens-Ford Glass Co.). U. S. 2,321,234, June 8. An anhydrous solution of urea-formaldehyde reaction product prepared by heating dimethylol urea, an acid, and *n*-butanol until most of the latter has evaporated.

PRESS LOADING DEVICE. G. B. Sayre (to Boonton Molding Co.). U. S. 2,321,252, June 8. A device for loading preformed pills into a multiple cavity mold and emptying the molded articles from the cavity in a continuous process.

IMPROVED PLYWOOD. A. J. Stamm and R. M. Seborg (to Secretary of Agriculture). U. S. 2,321,258, June 8. A plywood with highly compressed surface plies, wherein resin becomes distributed through the cell walls of the wood by treatment with water-soluble phenolic resin, drying below 120° F., assembling with untreated core, pressing with heat and finally cooling while under pressure.

THICKENING SOLUTIONS. K. D. Bacon and G. K. Greminger, Jr. (to Dow Chemical Co.). U. S. 2,321,270, June 8. An aqueous solution of an alkyl cellulose or a hydroxy alkyl cellulose containing an alkylated phenyl-phenol polysulfonate as a thickening agent.

VINYLIDENE CHLORIDE. A. W. Hanson (to Dow Chemical Co.). U. S. 2,321,292, June 8. A mixture of vinylidene chloride polymer and graphite.

DIAZINE-ALDEHYDE DERIVATIVES. G. F. D'Alelio (to General Electric Co.). U. S. 2,321,364, June 8. The reaction product of an aldehyde and a diazine derivative containing oxygen, sulfur, monovalent hydrocarbon and halo-hydrocarbon radicals, and divalent hydrocarbon and halohydrocarbon radicals.

ABRASIVE PRODUCT. N. P. Robie (to Carborundum Co.). U. S. 2,321,422, June 8. A coated abrasive consisting of a backing and a surface layer of abrasive grains attached with a glue, comprising polymers including a polyacrylate.

NEW RESIN. A. L. Ward (to United Gas Improvement Co.). U. S. 2,321,440, June 8. The product of the reaction of phenol with a light oil styrene fraction, in the presence of a condensation catalyst.

CONDENSATION PRODUCT. R. Bauer (to General Aniline and Film Corp.). U. S. 2,321,451, June 8. The product of condensation, in acid medium, of a phenol or thiophenol with a saturated aldehyde or ketone.

Hitch your Wagon to a

PLASTIC STAR*

Whether you are making battleships or airplanes, pianos or mouth-organs, darning needles or railroad spikes, somewhere, someplace, sometime, plastics will enter directly or indirectly into your product; and the inevitable result of the union will be gratifying and profitable in many ways and for many reasons.

It is our role on this earth to help in the application of plastic materials to an ever-widening field, and to make these applications as intelligently as possible, utilizing the best suited materials for the purpose, molded and fabricated in the most modern machinery and equipment available.

As your molder we assume a complete responsibility for your project from design to finished product.

The many intricate designs that are evolving around today's productive possibilities in plastics require skill, experience and versatility, qualities that are found in star performers only. We suggest that you consult TECH-ART where the vague and seemingly impossible dream is crystallized into solid reality in enduring plastics.

BB*

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MACHINERY and EQUIPMENT

★ SIMPLICITY OF DESIGN, RUGGED CONSTRUCTION and economical operation are the 3 factors stressed by Leominster Tool Co., Inc., Leominster, Mass., in designing its new granulating machine (below). Each granulator is supplied with 2 screen sizes, 1/4 and 9/16 in. The hopper can be swung back to permit free access for cleaning, and a shute on the side delivers the granulating material. The unit is available in 2 sizes: No. 1 equipped with a 3-hp. motor and capable of grinding 100 lb. per hr., and No. 2 with a 5-hp. motor that will grind 200 lb. per hour.

★ NEW BELLOWS-TYPE VACUUM PUMPS DESIGNED for production and laboratory applications have been introduced by American Automatic Typewriter Co., Chicago, Ill. Supplied with or without individual motor drives, these pumps come in 3 sizes, for drawing up to 7, 12 and 15 cu. ft. per min. at 4 in. of mercury. The pumps are of positive type; four bellows mounted within a square plywood frame are expanded and collapsed by a revolving crankshaft through connecting straps.

★ DESIGNED TO REDUCE UNWANTED MOISTURE IN plastic powder, improve the yield by eliminating cause of surface defects and reduce time involved in the molding cycle, Infra-Red Engineers, Inc., Cleveland, Ohio, have introduced an automatic plastic powder pre-heater and de-humidifier. The arrangement of heating lamps is designed to maintain the processed powder in pre-heated and de-humidified condition until used. Powder is fed into the pre-heater through a flow control hopper passing in a thin ribbon over a series of vibrator plates where the powder is subjected to heat rays from the infra-red panel. Particles are turned over and over so all surfaces have equal exposure to the rays.

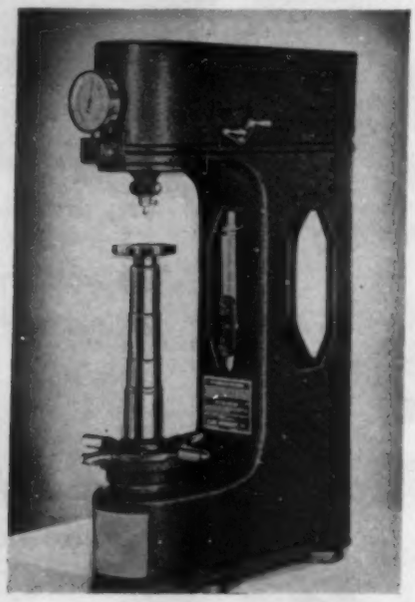
★ A NEW SAW-GUN ATTACHMENT FOR ELECTRIC drill, flexible shaft or compressed airline is described by Mid-States Equipment Co., Chicago, Ill., as suitable for sawing or filing plastics, castings or rod in places practically inaccessible to other tools. It is credited with cutting directly into wood or plastic without the drilling of a hole for a starter and of saving hours on panel notching, slotting and other fabricating operations. It is recommended for drill with a speed of 2000 r.p.m. or more.

★ DUPLICATING THE ACTION OF A MAN'S HAND with a sand block, the Detroit Surfacing Machine Co., Detroit, Mich., new electric sander attains a speed of 3000 strokes per min. against a possible 125 strokes in hand work. The machine is designed for cleaning up orange peel and irregularities in the surface of sheet, for de-burring, for removing scratches, waves and other imperfections in optically clear plastics. The sander weighs 7 1/2 lb. and consumes about the same amount of power as a 100-watt bulb.

★ A NEW CHIP BREAKER GRINDER DESIGNED FOR grinding the groove in carbide tipped tools but applicable to form tools, thread chasers and other units requiring accurate grind, is announced by the Delta Manufacturing Co., Milwaukee, Wis. One of its features is said to be a univise so constructed as to allow quick and easy setting at any angle. When the univise is removed, the unit can be used as a surface grinder.

★ BOICE-CRANE CO., TOLEDO, OHIO, OFFER OVER 60 models of their drill press now available in 1, 2, 3 and 4 spindle types of bench or floor design with high and slow speed. A feature is said to be the new self-centering 30° pressure angle, 6-tooth, involute spline. The quill held by 3 bearings, is designed to permit long holes to be accurately drilled. The same company has 2 sizes of tapping machines which operate at 3000 r.p.m. "in" and 6000 r.p.m. "out."

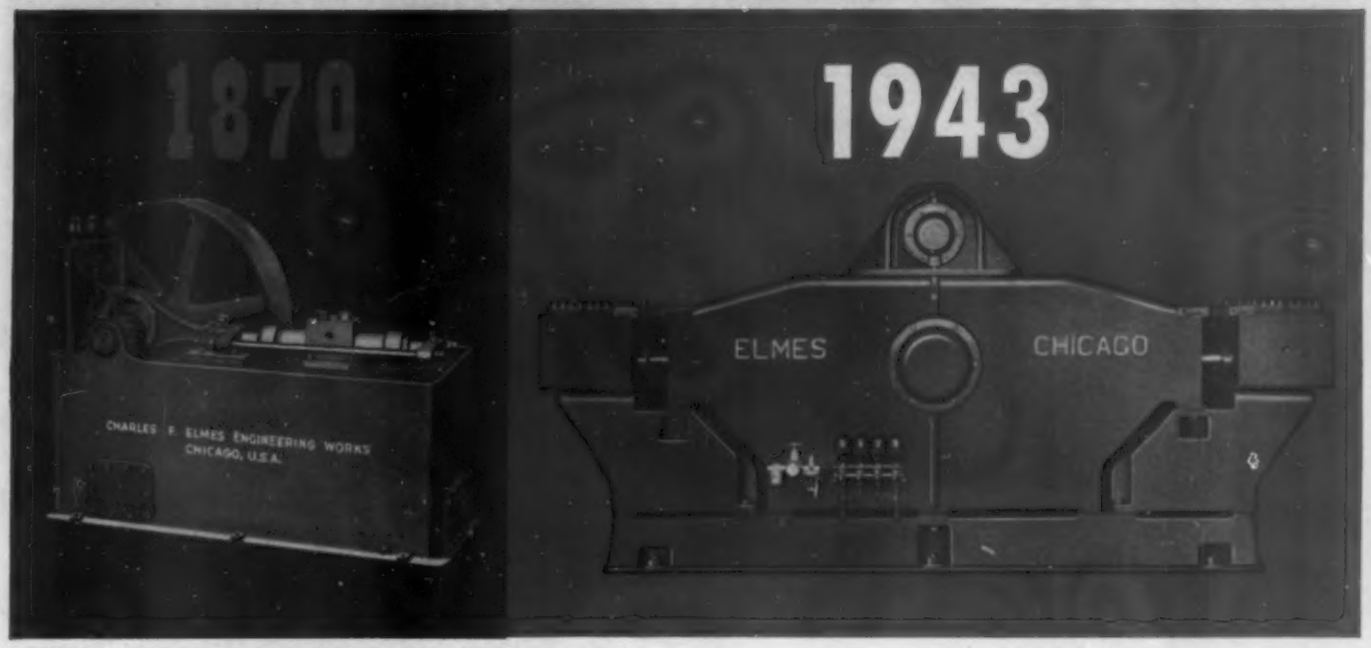
★ LYON-RAYMOND CORP., GREENE, N. Y., HAVE added several improvements to their hydraulic elevating table used in handling dies, locating work in convenient position for welding, transferring heavy parts from one level to another, supporting overhanging work and in operations where easy foot-actuated elevation is advantageous. Now the standard stock table can be furnished with 7 different optional features: a floor lock, spring-balanced towing handle, locking device, collapsible retaining bars, 4 swivel casters, stationary feet in place of casters, and a 2-speed hydraulic foot pump.



★ FEATURES OF AN IMPROVED HARDNESS TESTER for Rockwell testing manufactured by Clark Instrument, Inc., Dearborn, Mich., are a frictionless spindle said to provide a correct minor load at all times, a zero drag trip designed to eliminate friction on the loading beam and insure consistent accuracy of the major load, a dial indicator adjustment to afford an easy means of maintaining accuracy of readings, and a minor load adjustment. The instrument is supplied complete with diamond cone and steel ball penetrators for Rockwell testing on C, B and most other standard Rockwell scales. Three anvils also are included. (See illustration above.)

★ TO REDUCE FACTORY SHUT-DOWNS DUE TO valve failure, Albright Equipment Co., Johntown, Pa., offer their "Hydra" venturi-vacuum valves which are vacuum and pressure sealed. Available in 3 types, operating, neutral position and pump unloading, the valves are designed to operate easily without pilot valves. Made with steel forged body and stainless steel working parts, they are designed for air, oil and water from 500 to 6000 lb. working pressure.

PAST AND PRESENT OF A PUMP!



More than 70 years ago this Elmes 2-plunger, '4'-stroke job was a pumping sensation. Perhaps the first high-pressure pump made in this country, it established a principle of design which has since become the standard. Yet it merely carried on the quality tradition which has distinguished Elmes products for 92 years.

Compare that doughty 1870 Elmes model with an Elmes pump of today—such as the big, roller-bearing masterpiece of streamlined design and heavy-duty efficiency shown above. This 6-plunger, high-pressure unit with its 400 horsepower, was built for a highly specialized operation which called for extraordinary precision both in engineering and construction—and pressures of 35,000 pounds per square inch! It is a good example of the advanced hydraulic equipment that Elmes is supplying to modern American industry.

The ability of Elmes to build better hydraulic equipment springs from a background of continuous, progressive engineering achievement covering nearly a century. Many of the first hydraulic installations used in American industry were designed by Elmes, and today Elmes standard equipment represents the very highest hydraulic development.

The exceptionally complete Elmes standard line includes hydraulic presses, accumulators, valves, high-pressure pumps and other hydraulic equipment for every type of plastics manufacture and development. It makes greater economy and efficiency available in many operations not yet employing the full advantages of hydraulic power.

In the adaptation of basic hydraulic design to new and specialized plastics developments, the Elmes organization is likewise a leader. Plastics manufacturers, faced with unusual production problems, are finding their solutions in the broad experience, the inventive skill and the sound methods of our engineers.

Whether your needs are for standard or specialized hydraulic equipment, Elmes should be your first thought for cost estimates or engineering collaboration. Write today for information and literature on the type of equipment—or special problem—in which you are interested. ELMES ENGINEERING WORKS OF AMERICAN STEEL FOUNDRIES, 230 North Morgan Street, Chicago, Ill.

ELMES HYDRAULIC EQUIPMENT

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METAL-WORKING PRESSES · PLASTIC-MOLDING PRESSES · EXTRUSION PRESSES · PUMPS · ACCUMULATORS · VALVES · ACCESSORIES

PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

The Spirit of Enterprise

by Edgar M. Queeny
Charles Scribner's Sons, 597 Fifth Ave., New York, N. Y.
Price $2.00 **267 pages**

On these pages Edgar M. Queeny, chairman of the board of Monsanto Chemical Co., discusses his belief that America can best play her part in the postwar world under the free-enterprise system rather than under strong bureaucratic Government control. Evaluating the progress already achieved by our individualist American economy and summarizing the results of our recent experiments in a planned economy, Mr. Queeny reaches the conclusion that business and the collectivist planners have the same ultimate goal. However, he believes that the enormous contributions to civilization made possible by individual initiative operating under a free competitive system cannot be duplicated in a bureaucracy, and states his reasons for so thinking. Admitting that free enterprise has allowed certain abuses, the author points out how these can and should be corrected. L.E.M.

Electrical and Radio Dictionary

by Carl H. Dunlap and Enno R. Hahn
American Technical Society, Chicago, Ill., 1943
Price $1.00 **110 pages**

In addition to furnishing a full glossary of electrical and radio terms, this book is replete with drawings of electrical connections, resistors and capacitors, coils, contact and push buttons, switches, transformers and motors together with their architectural symbols. There also are diagrams of electrical and radio circuits. The last 16 pages are devoted to electrical formulas, tables of weights and measures and to the Electrical Code Standards.

★ TO GIVE THE EYE AS WELL AS THE MIND A BETter understanding of its family of plastics, Monsanto Chemical Co., Springfield, Mass., has interlarded its new bulletin, No. 1B/7, with full-page color cuts and striking charts giving comparative properties of each material. Since the bulletin is intended primarily as a guide for product designers, the company has included a compressed explanation of the various methods of molding together with a listing of 7 advantages deriving from the use of plastics. Detailed information on properties of individual materials in Monsanto's family of plastics, Nitron, Fibestos, Lustron, Resinox, Saflex and new melamine-formaldehyde resins, are given together with illustrations of typical applications.

★ TECHNICAL DATA BULLETIN NO. 4-243 HAS JUST been issued by the Electrochemical Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., treating of polyvinyl acetate, solid, solution and emulsion. Available grades and properties are listed and the behavior of representative solvents noted. A compressed statement is given of the applications of polyvinyl acetate.

★ AS AN EASY REFERENCE ON FIRE FIGHTING, Walter Kidde & Co., Inc., New York, N. Y., have published a file-sized booklet describing a method of teaching by demonstration. Supplementing the graphic lesson on fire fighting are several pages devoted to the various types of extinguishers, their operation and application to different types of fires.

★ THE 1943 CATALOG OF DELTA MFG. CO., MILwaukee, Wis., contains a complete listing of its line of production machine tools and woodworking production tools and accessories. Illustrations of the machines are complemented by specification charts and listings of special features. Inserted in the catalog is a company price list.

★ RECOGNIZING THE DIFFICULTY OF GETTING IN touch with proper war agencies in Washington, the OWI has prepared a "Handbook of Emergency War Agencies," defining the present functions of Federal agencies entirely devoted to war activities. Copies may be obtained at a cost of 20 cents by writing the Superintendent of Documents, Government Printing Office, Washington, D. C.

★ A 4-PAGE PAMPHLET, NO. 117, DESCRIBES THE Edge Moor Iron Works, Inc., Edge Moor, Del., line of horizontal mixers and blenders. Pictures are used to show both exterior and interior construction, and a chart gives detailed specifications of all sizes and types of mixers.

★ U. S. RUBBER CO., NEW YORK, N. Y., HAS PUBLISHED a booklet which, though designed for their sales representatives, is an excellent step-by-step guide to a clearer understanding of synthetic rubber. Beginning with a history of synthetic rubber development, this publication defines the 5 commercial types before giving a detailed description of each, their properties and applications. To insure complete comprehension, full pages are devoted to the definition and explanation of thermoplasticity, molecule, hydrocarbon, substitution, saturation, polymerization and vulcanization.

★ STAR FUSE CO., INC., NEW YORK, N. Y., HAVE ISSUED a leaflet describing their star-test pocket pliers used for testing and removing fuses. The testing indicator is a 10-watt carbon lamp that does not light on high-resistance moisture leaks, has a life of 1000 hours and can be replaced easily. Since only one hand is needed to operate this tool, danger of shock is reduced.

★ A WELL ILLUSTRATED CATALOG, NO. 113, HAS been issued by Titeflex Metal Hose Co., Newark, N. J., describing the company's line of flexible metallic tubing and fittings. In addition to detailing the manufacturing methods, a section is devoted to industrial applications and methods of attachment. Tables present the entire line in compact form.

★ LIGNUM-VITAE PRODUCTS CORP., JERSEY CITY, N. J., have published a booklet listing the many diversified wartime uses of lignum-vitae, a hard, resinous wood grown in the tropics. Several pages are devoted to excerpts from letters written by shipbuilders, mine equipment manufacturers, steel manufacturers and ordnance plant managers.

★ THREE FOLDERS GIVING COMPLETE INSTRUCtions for the proper use of resin glues for bonding have been issued by Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio. Described in their leaflets are ready-mix Type 250-2 used for assembly gluing and lumber laminating, and meeting requirements of Air Corps Spec. 14110; Type 700-2 hot-setting adhesive intended for use with the bag molding processes in making formed plywood and low-pressure laminates; and the rate of cure of unextended glues of the cold-setting type.

★ IN THE INTEREST OF PROPER SELECTION, MOLDing or application of its molding compounds, industrial resins and oil soluble resins, Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y., have published a fully illustrated, 20-page catalog on these 3 products. Properties charts facilitate the proper selection of material while line drawings show the right and wrong of mold design and insert application. Rather full application listing is given of industrial resins and oil soluble resins.

★ AS A GUIDE FOR PRODUCTION MEN IN REDUCING costs and labor, R. W. Cramer Co., Inc., Centerbrook, Conn., has published a condensed catalog describing its timers, their functions and applications.

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COMPOUNDERS AND EXTRUDERS OF SPECIFIC MATERIALS FOR SPECIFIC USES

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TEST DATA	FT-10 Sub-Zero	FT-11 Transparent	FT-22 Versatile	FT-33 Heat
Dielectric Strength				
Dry VPM	280	1000	1200	900
Wet VPM	450	910	900	800
Low Temperature Flexibility °F. (°C.)	−85 (−65)	−63.4 (−53)	−59.8 (−51)	−22 (−30)
Impact °F. (°C.)	−70.6 (−51)	−54.4 (−48)	−41 (−40.56)	−5.8 (−21)
Elevated Temperature Continuous °F. (°C.)	150 (65.56)	188.6 (87)	194 (90)	190 (87.78)
*Soldering	Flows	Flows	Flows	Good
**Aging (Baking) at 100°C. (212°F.) good after	100 days	100 days	130 days	50 days
Tensile Strength PSI	2550	3000	3200	2900
Hardness Shore "A"	40-45	55-60	65-70	75-80
Flame Resistance	Do not support combustion			
Water Absorption %	−1.4	+0.4	+0.9	+0.75
Chemical Resistance	Good	Very Good	Very Good	Good

All tests made on Standard #8 Tubing.
*1 minute immersion in molten solder at 450°F.
**Rapid flattening between jaws of a vise to thickness of twice the wall.

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WASHINGTON ROUND-UP

Current news, Government orders and regulations affecting the plastics industry, with analysis of the plastics situation

MACHINERY SITUATION FOR THERMOPLASTICS

During the past weeks there have been many WPB denials for thermoplastic machinery and molds. There has been a great deal of eyebrow lifting and no little complaint in the trade. The smaller manufacturers who have been on civilian goods up to the present time claim that they are being put out of business because they can't get war business to keep them going. The larger manufacturers who have spent thousands of dollars in experimentation and engineering at the Government's behest are not particularly cheerful about turning over their developments to rival companies and assert that they have not the experience and skill to turn out the highly complicated jobs. WPB is caught between the fire and is forced to do a tall amount of juggling in order to pacify all parties, and it must be understood that WPB has no intention of abandoning small companies.

But it is plainly evident that available machine time is increasing. There are three good reasons why: 1) scrap material is rapidly diminishing; 2) plastics are short; 3) civilian and some military items have been drastically curtailed.

When making application for machinery it should be remembered that WPB has set up a definite policy by which machines for any plant may be approved or denied. That policy runs about like this:

1. New machinery may be released only for war work and essential civilian goods. (Combs might be an example. Combs are essential, yet there is a big supply on inventory at present. Consequently, an application for a machine to make combs might be denied at present depending upon the inventory and material available. Certainly it is impossible at this moment to make combs from hard rubber, bone or horn because all are critical, but plastics, too, are very critical.)
2. It should be shown that the product for which new machinery is required cannot be produced on a sub-contract or prime contract basis by any other firm with available capacity. It would also be desirable to show that the product is of such technical nature that its production must be carried on in the applicant's plant, or that secrecy demands that it be produced in that plant.
3. Applicant must have the support of one or more of the Services if machine is for war work.

The following conditions govern the release of molds:

1. If for military use, the mold must be necessary to maintain essential production. Unneccessary duplication will be discouraged.
2. The supply of plastic material must be established.
3. Each application is checked with Armed Services. Check will determine whether mold is necessary.

Civilian molds:

a. Essentiality of product must be established.
b. Plastic material must be available.
c. No mold will be granted for even necessary items if there are molds in existence to produce the necessary minimum supply.

Plastic molds are approved and rated under L-159. These ratings are to be used only in scheduling the construction of the mold in the molder's or the mold maker's shop. Ratings so received may not be extended to mold makers for procurement of controlled materials. Mold makers must either

a. Use controlled materials from his allotment of same or
b. Apply on CMP-4-b for them.
c. If the molder builds his own mold he may use controlled materials from his allotment of same in accordance with CMP Regulation 5, allotment symbol MRO.

In the event that such requests are denied, the Plastics Section, Chemical Division, WPB, should be the point of appeal by the plastics manufacturer and his machinery or mold supplier.

THIN TYPE VULCANIZED FIBRE RELEASED

Because of great need and inability to find a satisfactory substitute, WPB has released .010-in. white tag stock vulcanized fibre for use as parts identification tags for the Armed Services. White tag stock of this same thickness can also be used as identification tags by laundries and dry cleaners. It is also permissible to use thin vulcanized fibre for heel seats and backing for rubber top lifts on women's shoes. Distribution of this material will be handled through allocation to producers as prescribed in M-305 and after concurrence with the shoe division of WPB and the Office of the Rubber Director in so far as vulcanized fibre for shoes is concerned.

This release of a special type of vulcanized fibre has been made possible because the situation is not so critical in the thickness band up to .020. Production is more rapid and the Armed Forces do not require so much as of the heavier fibre. Furthermore, experimentation has developed nothing that would take the place of vulcanized fibre without disentegrating when run through cleaning fluids and laundries. The thin material for shoes has been allowed because it makes a more substantial shoe when used as a heel seat, and as a backing for rubber lifts it prevents the rubber from spreading and helps to hold the nails more securely.

WHY THERE ISN'T ENOUGH VULCANIZED FIBRE

Before the European War broke out, vulcanized fibre capacity was equal to about three times normal demand. It is natural then that some former customers should question their inability to obtain at least a portion of their needed supply.

There are several answers. In the first place, the industry was always delicately balanced between paper capacity, processing capacity and puring capacity. The balance was adjusted for normal demand which is about evenly spread between all thicknesses. The war demand upset that balance because the services are principally interested in the thickness band between .045 in. and one-eighth inch. In that range are stop nuts, and parts for service gas tanks, jettison tanks, welders' helmets, crash helmets for tank crews and Lend-Lease.

In addition to this demand there has been an attempt to substitute vulcanized fibre for metal in large quantities for such things as file fasteners, file hangers, nameplates and literally hundreds of other items that would use up huge poundage.

Vulcanized fibre is chemically converted cellulose. In the process of making paper from the cellulose in cotton rags, zinc chloride must be removed from the laminated sheet after gelatinization has been completed. This is accomplished by leeching it out of the fibre in puring tanks.

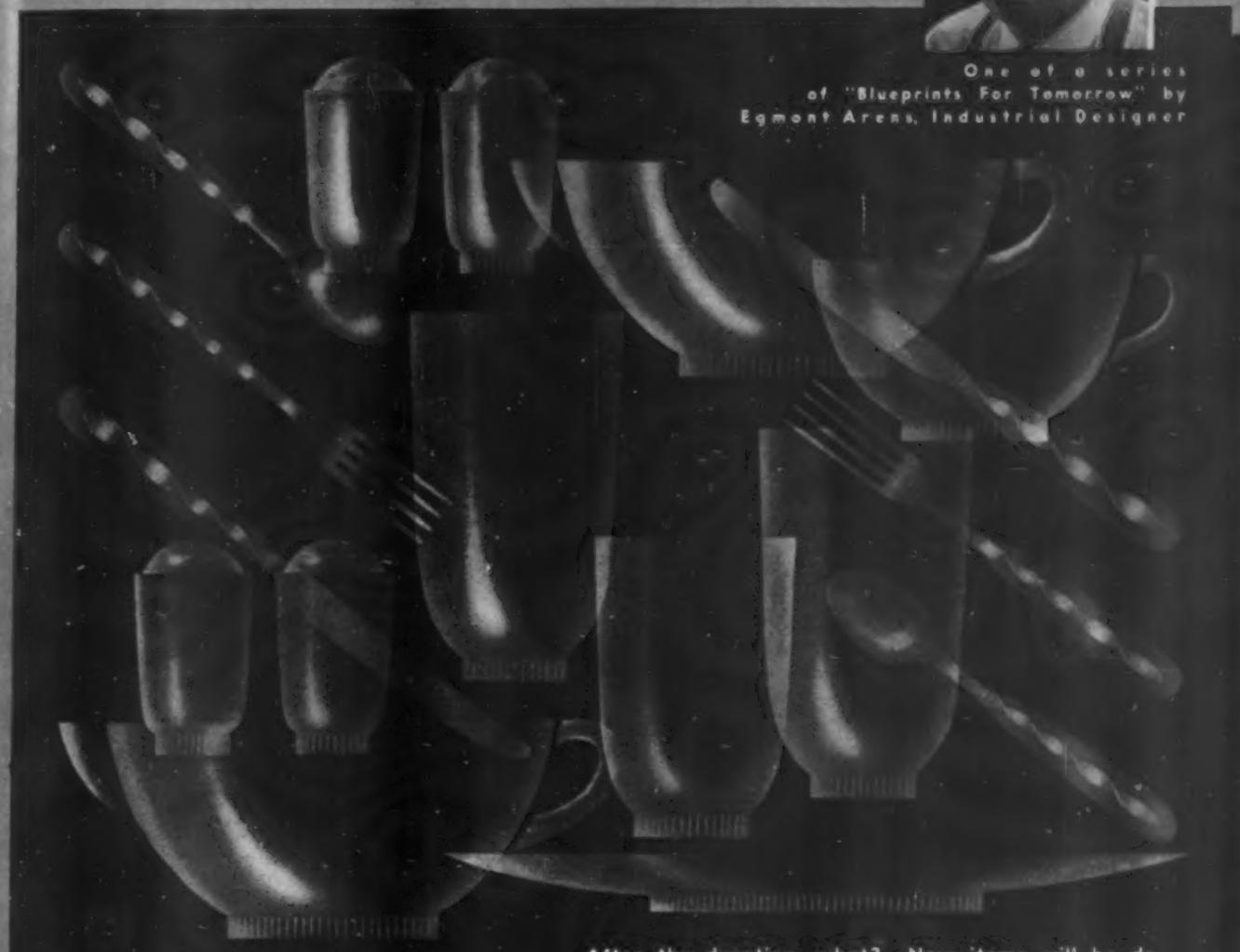
Various attempts have been made to correct the balance by adding puring tanks, bringing in paper from other than the usual sources, adding dry house capacity and a long list of similar corrective measures. The balance has to a large extent been rearranged to suit war-time demands. Although the industry has done a tremendous job in rearranging facilities to increase production, it is unlikely that any additional capacity can be added due to the amount of critical material required and to a lack of trained personnel.

The personnel problem is particularly acute because vulcanized fibre making is not a science, is not a definite washing and

APPETIZING PROSPECTS FOR

Plastic Tableware

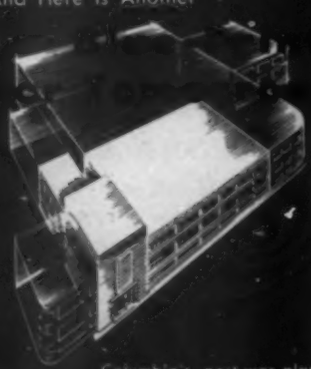
One of a series
of "Blueprints For Tomorrow" by
Egmont Arens, Industrial Designer



After the duration, what? New items will be demanded . . . like this "classic-modern" plastic tableware, designed for moderate-priced mass marketing. Says Egmont Arens, "Streamlined merchandise of better design, using the beautiful new transparent crystal, pastel and translucent plastic materials soon available, will have tremendous consumer appeal in post-war markets."

Columbia injection molded plastics have scored spectacular successes in the mass-consumer field, have sold in millions across the chain store counters of America. Columbia experience, and Columbia vision for the future can help to solve your mass-market problems . . . after the duration.

And Here Is Another



Columbia's post-war plans are being readied for a great superplant that will have a capacity far greater than ever to meet your peacetime custom-molding requirements.

BUT TODAY Columbia's facilities for injection molding are devoted to the war effort. Prime or secondary contractors on war or other essential products will find us whole heartedly cooperative to the extent of available capacity. If you have an essential problem, call or write Columbia.

COLUMBIA-p

PROTEKTOSITE CO., INC.

CARLSTADT, N. J.

custom plastics

beating process conducted according to a predetermined routine. It takes a well-trained paper mill foreman to pick up a handful of half-stock from the beater, squeeze the water out and pull the cotton fibres apart in order to determine the length of the cotton fibres and degree of hydration. And it is only after this analysis that correct orders can be given for further processing of vulcanized fibre to compensate for the irregularities in the rags.

It takes many years to train expert personnel in this procedure, and from two weeks for .010-in. sheet to 15 months for 2-in. sheet to produce vulcanized fibre. Therefore, even if it were possible to add millions of dollars worth of new facilities, the shortage could not be overcome until more trained manpower and many months of time have been accumulated.

NEW STAFF HEADS IN THERMOPLASTICS UNIT

The Thermoplastics Unit of the Plastics Section in the Chemicals Division of WPB, formerly administered by James Turnbull, who has returned to Monsanto Chemical Co., has been split into two sections, Thermoplastics Section and Vinyl Resins Section. George H. Sollenberger will be chief of Thermoplastics and Robert P. Kenney will head up the Vinyl Resins Section.

Mr. Sollenberger served in the engineering and technical sales development department of Rohm and Haas before joining WPB's Plastics Section last September and has been administrator of M-260 (Acrylics) and M-170-a (Polystyrene). Mr. Kenney, formerly of the product development section of Union Bag and Paper Corp., specializing in plastics and synthetic rubber protective coatings, joined WPB in January 1942 as one of the original staff members of the Plastics and Synthetic Rubber Section. He has been with the Thermoplastics Unit ever since it was organized and supervised administration of the vinyl polymer and vinyl acetate monomer orders.

RENEGOTIATION PROCEEDINGS ACCELERATED

The rate of renegotiation of war contracts by the War Department Price Adjustment is being substantially accelerated, the War Department has announced. In the four weeks period ending June 19, 1943, written or verbal settlements were reached with 713 war contractors, or 43 percent as many as the 1658 cases settled in the period of almost 13 months from April 28, 1942 to May 22, 1943. As of June 19, a total of 10,741 contracting companies had been assigned for renegotiation by the War Department Price Adjustment Board. Twenty-two percent had been settled; 42 percent were then engaged in renegotiation. It is estimated that the total number of war contractors subject to renegotiation by the War Department is approximately 15,000.

At the present time, the clearance and assignment officer of the 5 Price Adjustment Boards of the War, Navy and Treasury Departments, the Maritime Commission and the War Shipping Administration is mailing to war contractors, a new 2-page form devised to help avoid making unnecessary assignments for renegotiation of war contracts to eliminate excessive profits under Section 403 of the Sixth Supplemental National Defense Appropriation Act, as amended, and calling for certain operating and financial data.

The data are required to be filed within two weeks from the date of the letter, and time extensions will be granted only in unusual cases. Copies of the form and instructions for filling it out may be secured by writing to Departmental Price Adjustment Boards, P. O. Box 2707, Washington, D.C.

CHEMICAL PRODUCTION MATERIAL DEFINED

The War Production Board has issued Interpretation No. 1 of Priorities Regulation 11-B clarifying the definition of "production material" in relation to chemicals. (Priorities Regulation 11-B provides for priority assistance to certain manufacturers who do not obtain production materials under CMP regulations.) The term "production material" includes material which, at any stage of production, enters into the chemical reaction necessary to the manufacture of an unclassified product. It also includes any material which is used as a solvent, wash or extractant, at any stage of the production of chemicals.

GLYCOL ETHERS UNDER ALLOCATION

Glycol ethers have been placed under allocation control by the War Production Board by Allocation Order M-336. Glycol ethers are used in the manufacture of plasticizers for synthetic resins, as solvents in protective coatings, and in miscellaneous solvent and chemical uses throughout industry. The order provided that on and after July 1, 1943, no supplier (producer or distributor) may deliver glycol ethers to any person except as specifically authorized or directed in writing by WPB.

CHEMICAL TANK CAR TRANSPORTATION SAVINGS

The Chemicals Division of the WPB has announced that approximately 150,000,000 ton-miles of chemical tank car transportation have been saved in the first three months' operation of the War Production Board Transportation Order T-1. The order was recently retitled General Haulage Conservation Order T-1. Additional savings are also being made through administration of WPB chemical orders which allocate some 200 chemicals to individual customers, generally from the nearest available producing point. Order T-1 is for chemicals which are not in themselves scarce enough to require an allocation order, but which, nevertheless, do use tank cars. Order T-1 and its companion Transportation Requests are the only transportation controls ever issued for administration in WPB.

CELLULOSE PLASTICS ALLOCATION ORDER AMENDED

Amendment of Supplementary Allocation Order M-326-a, issued by WPB July 9, 1943, changes the procedure for filing applications and securing monthly allocations of cellulose plastics. The timing of the applications and allocations is changed from the basis of the month in which deliveries are to be made to the basis of the month in which the cellulose plastics are to be put into production. Consistent with this change an exemption was added to the order providing that cellulose plastics in process of manufacture on or before July 1, 1943, can be disposed of by the suppliers without WPB authorization.

ANILINE UNDER ALLOCATION

According to the terms of Allocation Order M-184 as amended July 5, 1943, no person shall accept delivery of 5000 lb. or more of aniline in the aggregate from all suppliers during August 1943, or during any calendar month thereafter, except as specifically authorized in writing by the War Production Board, upon application. Nor may any person place any purchase order for delivery of between 500 and 5000 lb. of aniline unless and until he has furnished each supplier with a use certificate.

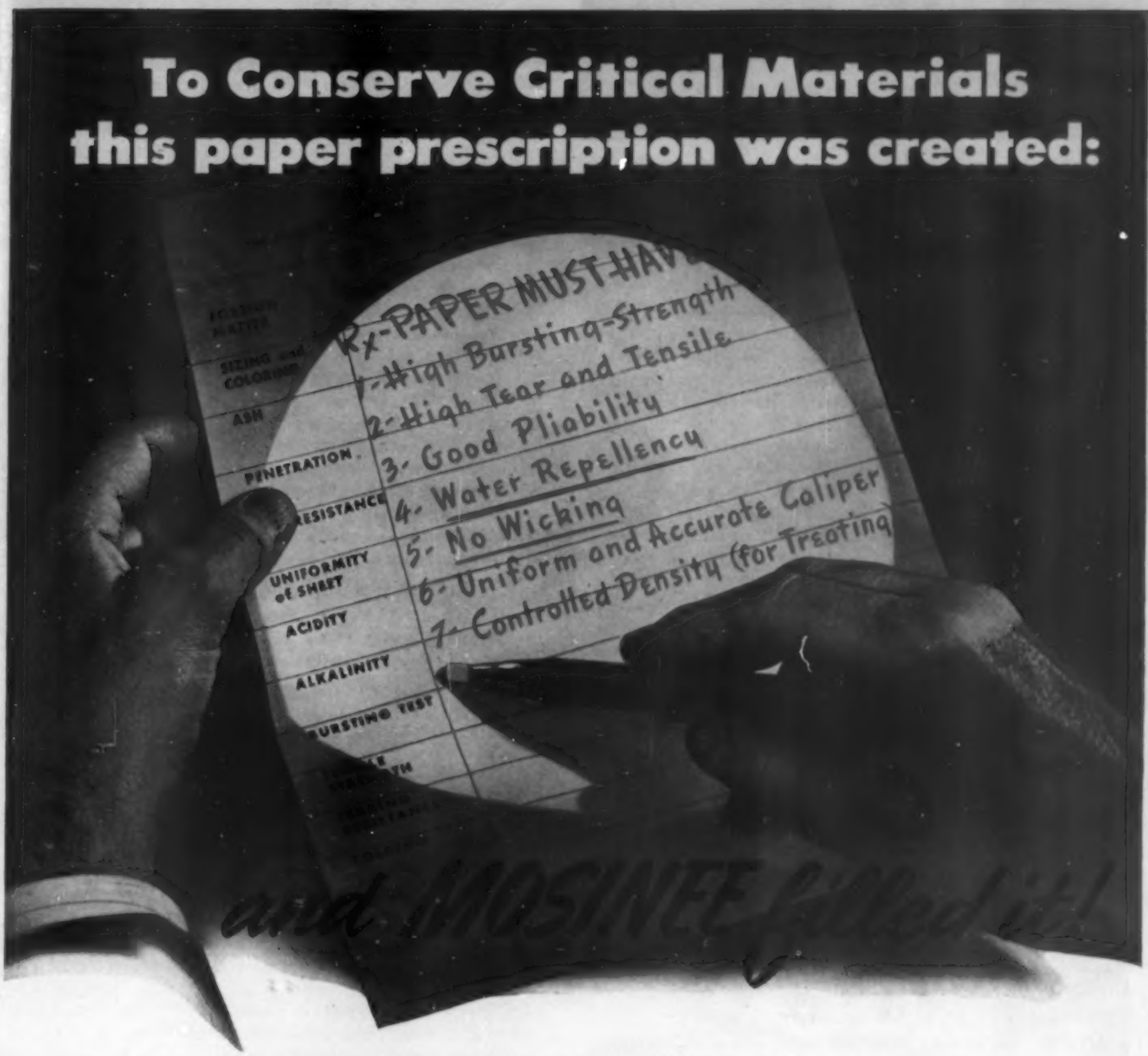
GLYCOLS ALLOCATION ORDER

Under the amended Order M-215, each person seeking authorization to accept delivery of glycols is required to prepare a set of 5 copies of Form PD-600. One copy is retained by the applicant and 4 certified copies must be forwarded to the Chemicals Division, WPB, Washington, D. C., Ref: M-215. Receipt by a supplier of a copy of Form PD-600 signed by WPB constitutes authorization to make deliveries of glycols called for by the form. Suppliers are required to file one set of PD-601 forms for all types of glycols. Two copies must be forwarded to the Chemicals Division.

USE OF ENEMY OWNED PATENTS

Beginning August 1, 1943, the fee for obtaining a license to use enemy owned patents held by the Alien Property Custodian will be a flat $15 for each patent (*Please turn to page 150*)

To Conserve Critical Materials this paper prescription was created:



Shortage of critical materials forced a manufacturer of vital war products to seek practical replacements for such materials. As many other manufacturers have done, this one discussed his problem with paper technicians of The Mills of Mosinee . . . and the above "prescription" was developed. The paper, made by Mosinee, is "serving the war effort" with complete satisfaction.

Whether your product demands high bursting-strength . . . dielectric, tear or tensile strength . . . pliability, controlled acidity or alkalinity . . . water repellency, accurate caliper, uniform density or other technical characteristics . . . discussions with Mosinee's engineers may disclose valuable opportunities for you in modern "Essential Papers."

Please address your letter "Attention Dept. A"

MOSINEE PAPER MILLS COMPANY
MOSINEE • WISCONSIN
Essential Paper Makers

IN THE NEWS

★ THE ARMY-NAVY "E" AWARD WAS PRESENTED on July 23 to the men and women of General Electric Co., Plastics Div., Pittsfield, Mass. It is in Pittsfield that a large section of the compression molding research laboratory of this custom molding plant is located.

★ "PLASTICS TODAY AND TOMORROW," AN EXHIBITion of the uses of plastics in the war effort and in the postwar world, opened at the Art Gallery of the Yale School of Fine Arts in New Haven, Conn., on July 19 and will continue through August 14. Sponsored by Yale University, the exhibit was arranged for and collected by MODERN PLASTICS in the belief that it would provide a graphic demonstration of the versatility of the industry and stimulate the interest of schools of higher education in the opportunities open to them for furnishing trained and skilled personnel for the plastics industry. The several thousand plastic items ranging from a plastic set screw the size of a pin head, to the molded fuselage of an airplane, were supplied through the courtesy of a long list of companies.

A special preview of the exhibition was held for members of the faculties of the Yale Engineering School, the School of Fine Arts, and the Sheffield Scientific School, and industrial representatives on Friday, July 16. Following brief addresses by Dean Samuel W. Dudley of the Engineering School, and Everett V. Meeks, Dean of Fine Arts, the motion picture, "This Plastic Age," was shown.

★ RAY C. WHITMAN HAS BEEN NAMED SALES MANAger of Makalot Corp., Boston, Mass. Previously Mr. Whitman was associated with Agicide Laboratories, Inc.

★ EMPLOYEES AND MANAGEMENT OF NORTHWEST Plastics, Inc., have been awarded the Army Ordnance Banner for meritorious production by the Chicago Post of the Army Ordnance Association.

★ A WHITE STAR IN RECOGNITION OF MERITORIous services on the war production front has been added to the Army-Navy "E" at the Lancaster, Pa., plants of Armstrong Cork Company.

★ MORRIS SANDERS, industrial designer, has been retained as technical adviser for Vidal Research Corp.

★ WITH THE OBJECT OF PROCESSING CHEMICALS recovered from the distillation of coal in by-product coke ovens, Interlake Chemical Corp. has been organized under Delaware laws with an authorized capital of 5 million dollars, as a property jointly owned by Interlake Iron Corp., Chicago, Ill., and Great Lakes Steel Corp., Detroit, Mich. The corporation plans to break down recovered naphthalene and various tar acids into phenol, ortho cresol, meta para cresols and xylenols as well as other chemicals used in the manufacture of plastics, lacquers, dyestuffs and pharmaceuticals.

★ BUSINESS OF MARCO CHEMICALS, PHILADELPHIA, Pa., has been transferred to Marco Chemicals, Inc., now located at Sewaren, N. J. Irving E. Muskat is president while the substantial interest which Continental Can Co., Inc., and Vulcan Detinning Co. have acquired in Marco Chemicals, Inc., are represented by Carle C. Conway, chairman of Continental Can Co., Inc., and W. J. Buttfield, president of Vulcan Detinning Co.

★ CANADIAN BRIDGE ENGINEERING CO., LTD., Walkerville, Ontario, has entered into an agreement whereby it will develop in Canada all plastic products of Columbian Rope Co. of Auburn, N. Y. At present the Canadian company will prepare impregnated sisal fiber sheets and preforms from materials supplied by the Columbian Rope Co.; later it will import the fiber and manufacture the whole product.

★ FEDERAL PUBLIC HOUSING AUTHORITY, AFTER exhaustive tests extending over several months, has authorized the use of saran tubing and fittings for water lines in publicly financed war housing. Extruded by several firms, the tubing will be available through regular distribution channels in virtually all parts of the country. The FPHA, however, recommends saran for use in areas with difficult water conditions such as the eastern seaboard, some of the southern states and the 2 northwest states of Oregon and Washington. This suggestion is based on the fact that saran prices will compare with copper tubing and fittings considered desirable in the past for hard water.

Present arrangements call for the manufacture of some 600,000 ft. of tubing and 200,000 fittings per month. For this preliminary 3-month program, plans call for use of these parts in 5000 dwelling units per month or in a total of 15,000 units. Savings in galvanized steel pipe are calculated to approximate 500 tons. The tubing will be used for both hot and cold water lines. However, for connections between waterbacks and range boilers, between direct fired coal water heaters and storage tanks, and for overflow lines from relief valves, FPHA recommendations call for the use of standard weight galvanized iron pipe. FPHA instructions note that the tubing, coming in 3 sizes—$^3/_8$, $^1/_2$ and $^3/_4$ in.—and with a nominal wall thickness of .062 in., is considered safe within a range of 200° F. and 100 psi. working pressure.

★ E. I. DU PONT DE NEMOURS & CO., INC., WILMINGton, Del., has completed a new plant at Leominster, Mass., for the production of acrylic resins to be used for bomber noses, gun turrets and other transparent enclosures for military aircraft.

★ STRICKER-BRUNHUBER CORP., 19 WEST 24TH ST., New York City, announce the change of their firm name effective July 1, to Stricker-Brunhuber Co.

★ PRODUCTION RECORD OF EMPLOYEES AND MANAgers of the Bridesburg, Pa., plant of Resinous Products & Chemical Co., Philadelphia, was recognized on July 2 with the awarding of the Army-Navy "E."

★ TWO NEW FORMULATIONS, SYNFLEX FT-11 AND SYNFLEX FT-22, have been announced by Industrial Synthetics Corp., Irvington, N. J. Synflex FT-11, a transparent, flexible tubing developed for extreme sub-zero use and having a wide range of working temperatures, is intended to facilitate circuit and wire code identification and permit immediate inspection of soldered points or connectors without removal of insulating sleeves. Synflex FT-22 is described as a versatile, rubber-like synthetic for electrical insulation and for many non-electrical applications where it replaces varnished tubing, rubber, tin, aluminum, etc. Both materials are said to have excellent chemical resistance and low water absorption.

★ THE CHEMICAL INDUSTRY MEDAL FOR 1943, awarded annually for valuable application of chemical research to industry, will be given Dr. John J. Grebe, director of Physical Research Laboratory, Dow Chemical Co., Midland, Mich., at a meeting of The American Section, Society of Chemical Industry, to be held in New York City in November.

★ ACCORDING TO INFORMATION APPEARING IN the February issue of the British publication, *The Chemist and Druggist*, an Australian company engaged in making synthetic phenol, sulfanilamide and other chemicals, recently has almost quintupled the amount of its capitalization.

★ J. EARL SIMONDS, EASTERN TECHNICAL DIRECtor of Plastics Industries Technical Institute, announces his resignation effective July 15, 1943. Mr. Simonds' plans for the future will be announced in a forthcoming issue.

★ ANNOUNCEMENT HAS BEEN MADE OF THE REcent death of O. W. Doll who was associated with Lester Engineering Co., Cleveland, Ohio. Prior to the outbreak of war, Mr. Doll was managing director of Dowding & Doll, Ltd., of London, and connected with the firm of Injection Moulders, Ltd.

(*Please turn to next page*)

AT 40° BELOW

—and

140° Above

INSTRUMENTS and PARTS MADE FROM REILLY PLASTICS ARE MEETING THE TESTS OF WAR . . .

★ In bombing planes five miles high, where the temperature goes down to 40° below—and in tanks and tank busters lurching through deep desert sands under a searing, scorching sun where the temperature goes up to 140°—essential equipment employing REILLY PLASTICS is meeting the severest tests of modern warfare.

Light weight, mechanical strength, dependable electrical insulation and protection against heat, moisture, oils and acids are among the characteristics that make REILLY PLASTICS vital materials for war—and for peace.

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★ H. L. ANDREWS, VICE-PRESIDENT IN CHARGE OF the Appliance & Merchandise Dept., General Electric Co. at Bridgeport, Conn., has announced the formation of a Resin and Insulation Materials Div. with E. L. Feininger as manager. Other appointments to this division include that of C. K. Mead as sales manager, C. S. Ferguson as engineer, H. K. Collins as superintendent and E. T. Kilgore as accountant.

★ LEE B. GREEN HAS BEEN APPOINTED EXECUTIVE vice-president and general manager of Designers for Industry, Inc., Cleveland, Ohio. Mr. Green has relinquished his position as manager of Firestone Rubber & Metal Products Co.

★ ENCOURAGED BY THE SUCCESS OF AN EARLY meeting on postwar planning, Carrier Corp. was host to representatives of 20 additional firms at a Post War Forum held in Syracuse, N. Y., on May 6 and 7. At both forums, 3 points were adhered to: that the representatives be actual working members, not figureheads; that there be no set speeches and no formality; and that the group be kept small to permit round-table discussion. Edited proceedings of the last meeting are available in booklet form.

★ A NEW ADHESIVE DEVELOPED BY THE PLASTICS Dept. of E. I. du Pont de Nemours & Co., Inc., after a year-long search for a crude rubber replacement, has been approved by the Army Air Corps and Navy. The adhesive was developed primarily for sealing masking paper to highly polished optical surfaces of plastic enclosures. In meeting its rigid requirements, the new product is claimed to withstand extreme temperatures, strip easily and cleanly, have no chemical effect on the plastic, retain its adhesive qualities for a long time, and not to curl at edges nor peel in sunlight. It is applied to paper by the same equipment used for crude rubber cement. The petroleum base is purchased from an oil company and dispersed in various chemicals to form the adhesive.

Sorry!

★ IT HAS BEEN CALLED TO OUR ATTENTION BY THE Materiel Command, Army Air Forces, Wright Field, that there were several misstatements in the article, "Air Corps Flashlight" which appeared in the May issue, page 63.

1. The unit (Type A-8, Specification No. 94-32413) described is not 100 percent vapor-proof and no requirements appear in the specification for being vapor-tight.
2. Tenite II or an equivalent material was specified for the housing of the Type A-8 flashlight in order to conserve strategic material.
3. The Type A-8 flashlight is not specified for use in aircraft nor was it designed by the Army Air Forces. However, Specification 94-32413 was prepared by the Materiel Command to cover a flashlight of this general design. This type flashlight was originally submitted for test as a mechanic's flashlight by Justrite Mfg. Co. to supersede the standard tubular type.
4. Procurement of 30,000 of these flashlights was made from Changeable Neon Co. but this contractor is now making changes in design to meet all requirements of the specification.

★ THROUGH ERROR, DILLON-BECK MFG CO. WAS not listed as both the molder and sole distributor of the collapsible plastic razor described on page 60 of the July issue.

★ IT HAS BEEN CALLED TO OUR ATTENTION THAT, in the article on "Chemical resistance of laminates" in the July issue, the footnote identifying the materials referred to in the charts on pages 82, 83 and 84 has been dropped. This legend should read as follows: A = asbestos fabric, regular type phenol resin; B = heavy cotton cloth, regular type phenol resin; C = fine weave cotton cloth, chemical-resistant phenol resin; D = medium weave cotton cloth, chemical-resistant phenol resin; E = chopped laminated heavy cotton cloth, regular type phenol resin; F = chopped laminated fine weave cotton cloth, chemical-resistant phenol resin.

S.P.I. News

Despite the season, SPI activities continue at a high pitch. The previously announced program of the New York Chapter calling for four monthly meetings got off to a good start with the initial gathering at the Sert Room of the Waldorf-Astoria on Thursday evening, July 15. George Scribner, president of SPI, outlined the purpose and need for talks of the type scheduled on the program and introduced C. J. Uhlir, principal speaker of the evening. Previously the group heard from Peter Allen, managing director of Imperial Chemical Industries, Ltd.'s, Plastic Group, who had an interesting message on the plastics industry in England.

Mr. Uhlir is head of the Department of Industrial Relations of the National Metal Trades Association. He and his organization have pioneered a highly successful system of job and employee ratings which has been installed in over 400 manufacturing plants of various types throughout the country and the experience thus gained has at last resulted in methods of applying job and individual ratings which are very nearly fool-proof. Keeping posted on the level of wages being paid on comparable jobs in the industry can be accomplished, Mr. Uhlir said, only through the development of periodic wage rate surveys set up on the basis of geographical location and allowing for ready identification of comparable jobs. To ascertain if there is an equitable pay relationship between different jobs in the same plant "job rating" is used, Mr. Uhlir pointed out. Job rating he described as the system of analyzing a particular job on the basis of required training, skill, effort, responsibility and working conditions, from which the proper wage differential may be determined. Mr. Uhlir warned that under the "Hold the Line Order," no increases or adjustments in rates of pay may be made without authorization by the War Labor Board.

On Thursday, August 19, 1943, at 8:00 P.M., the second meeting in the series will be held in the Sert Room with Phil Carroll, Jr., business consultant, speaking on "Wage Rate Incentive Plans."

• • •

Voting representatives of Chicago company SPI members met at the Edgewater Beach Hotel in Chicago on June 25, 1943, to take up the question of establishing a local SPI Chapter. Mr. George Scribner advised the group that SPI directors had discussed the idea of establishing local chapters and were agreed that such a step would be desirable where conditions are propitious. He stressed the advantages of the local chapter set-up including the possibility of the industry being able to give special attention to its own local interests and problems.

Speaking of the other local plastics associations such as SPE, PPC, PEA and PCA, Mr. Scribner paid tribute to their inception and objectives but said he was hopeful that a plan could be formulated which would permit of their members enjoying the benefits of the national SPI organization.

• • •

Participation and interest in the SPI monthly sales statistics continue to grow with 68 molders and extruders regularly reporting their individual figures for compilation into industry totals. It is estimated that over 60 percent of the total dollar volume of finished plastic molded articles are now shown in the industry reports. The figures go back through January of the present year and as additional months are reported some interesting trends likely will develop. Participation in the sales statistics program is open to all SPI molder and extruder members with work of reporting held to a minimum. Judging from comments of those now receiving the monthly reports, they are proving highly informative on current sales conditions.

• • •

The Program Committee promises an interesting program with speakers on topics of national importance for the Fall Meeting of the SPI, to be held on November 8 and 9, at the Hotel Waldorf-Astoria, New York City. Reservations and information may be obtained from Wm. T. Cruse, 295 Madison Ave., N. Y.

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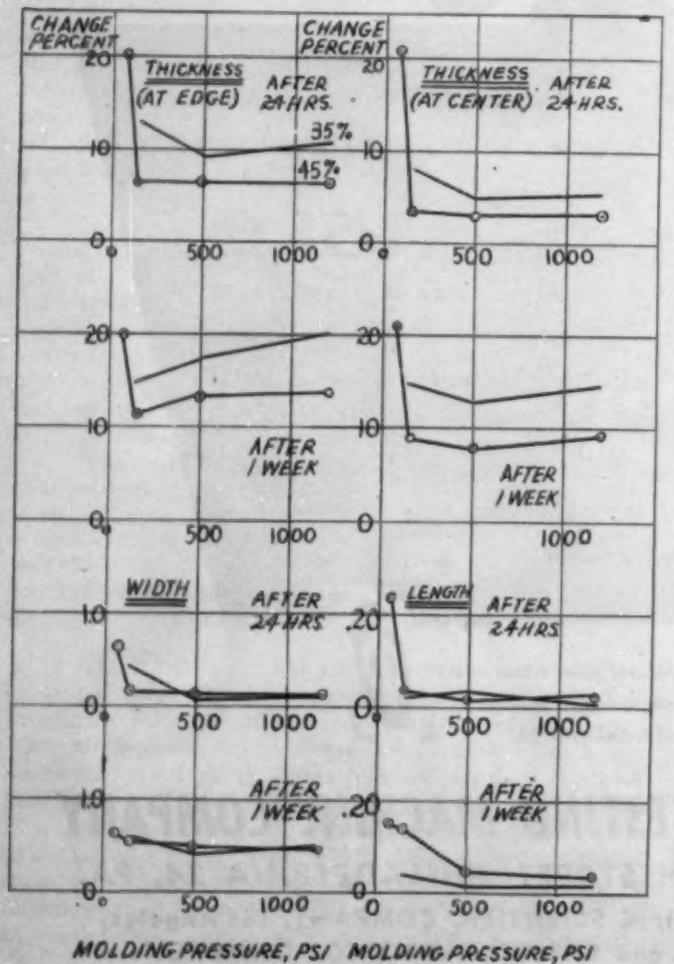
Properties of laminates

(*Continued from page 102*) strength paper and kraft material based on a 24-hour immersion, and for the latter material based on immersion periods of one week and one month. Although high pressure reduces the amount of moisture absorption based on a 24-hour test, the relative advantage decreases sharply on longer exposure. The conclusion to be drawn is that all of these paper base laminates should be given protective coatings.

It is important to prevent the absorption of moisture because it affects dimensional stability and warpage. Figure 19 shows the percentage change in length, width and thickness versus molding pressure for kraft-phenolic laminates of 35 and 45 percent resin content. The length and width are not affected greatly, but the thickness is. As with the moisture absorption, the relative superiority of the high-pressure laminates decreases with time of immersion. Increasing resin content tends to improve dimensional stability and vice versa.

The general trend in the physical properties obtained with different molding pressures is shown in Fig. 20. In general the values increase rapidly for pressures up to 100 lb. and then increases very slowly. The flexural modulus seems to decrease between pressures of 100 to 500 p.s.i., and then increase slowly. Data on high-strength paper are shown in Fig. 21, which gives absolute values and specific values (related to the specific gravity). The absolute values decrease with lower pressures for all properties, but the specific flexural strengths are approximately equal. With regard to specific yield strength, the high pressure is better, but in specific flexural modulus, the low pressure is superior. None of these data shows any great advantage from the structural or stability standpoint to be gained by the use of high pressures.

19—*Dimensional stability versus molding pressure for kraft-paper phenolic laminate (see Table XII, page 102)*



Comparison with metals

The possibility of using plastic materials in aircraft is partly dependent on their strength-weight ratios. A quick comparison can be made with 24ST aluminum alloy by using specific strengths (see Definitions). This comparison is given in Table XIV. The data show that the high-strength paper is superior to 24ST aluminum alloy in buckling even at a temperature of +160° F.

Variability

One of the objections raised by commercial laminators to the introduction of low pressures is the difficulty of assuring uniformity of product. It is probable that more care and finer control are required to produce consistently a uniform product when low pressure is used.

The degree to which uniformity has been achieved by low-pressure lamination of high-strength paper is indicated roughly in Fig. 16. For three suppliers the plate shows the minimum, maximum and mean values obtained in compression, tension and flexure for materials supplied by each manufacturer. The chart also shows corresponding data for the 3 manufacturers combined, the variability representing the range of values which would be expected if a buyer went into the market to procure high-strength paper laminate, regardless of supplier.

The compressive ultimates of P1 and P2 are each uniform, showing deviations from the mean of less than $2^1/_2$ percent, while for P3 the value is 6 percent "with grain" and 10 percent "cross grain." There is also a spread in the mean values for different suppliers, P1 having lowest values and P2 the highest. Combining the data for all companies, the deviation from the mean is approximately 10 percent, the lowest value being 18,000 p.s.i. The variation in yield strength is considerably less, being approximately 6 percent for all suppliers.

The largest variations are found in the tensile strength, deviations from the mean being over 8 percent for P1 for both ultimate and yield. For all companies, the deviation is over 20 percent for ultimate (with grain) and over 23 percent for the corresponding yield.

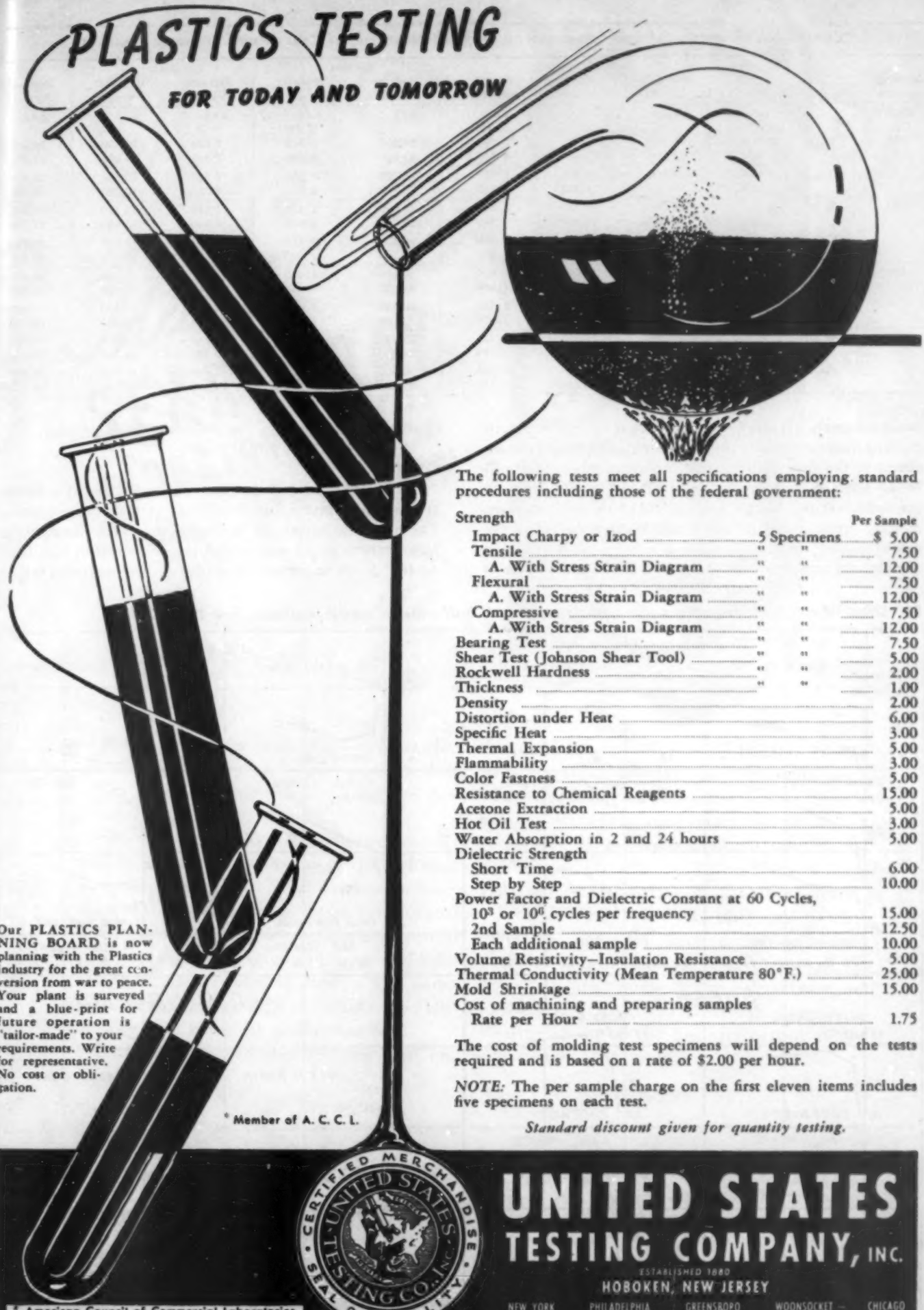
In flexural properties the variation for each material is not bad, being less than 5 percent for the modulus of rupture and modulus of elasticity. However, there is such a wide variation of mean values for each material that, for the group as a whole, the deviations for the modulus of rupture and modulus of elasticity are over 20 and 17 percent, respectively.

At the present stage of development, high-strength paper laminates occupy a marginal position with regard to their use in aircraft structures. In a material like aluminum alloy, considerable variation is encountered from sheet to sheet, but the material is acceptable even based on minimum values. On the other hand, minimum strength values of the high-strength paper laminates supplied by some manufacturers would preclude their use in aircraft. It is, therefore, necessary for all laminators to raise the level of physical properties of their products to that of the best which the industry can produce and to maintain a high degree of uniformity. That this is possible is clearly indicated by the properties exhibited by the P2 material, made by one of the larger laminators.

The data that have been presented were obtained on lami-

PLASTICS TESTING

FOR TODAY AND TOMORROW



The following tests meet all specifications employing standard procedures including those of the federal government:

			Per Sample
Strength			
Impact Charpy or Izod	5 Specimens		$ 5.00
Tensile	"	"	7.50
A. With Stress Strain Diagram	"	"	12.00
Flexural	"	"	7.50
A. With Stress Strain Diagram	"	"	12.00
Compressive	"	"	7.50
A. With Stress Strain Diagram	"	"	12.00
Bearing Test	"	"	7.50
Shear Test (Johnson Shear Tool)	"	"	5.00
Rockwell Hardness	"	"	2.00
Thickness	"	"	1.00
Density			2.00
Distortion under Heat			6.00
Specific Heat			3.00
Thermal Expansion			5.00
Flammability			3.00
Color Fastness			5.00
Resistance to Chemical Reagents			15.00
Acetone Extraction			5.00
Hot Oil Test			3.00
Water Absorption in 2 and 24 hours			5.00
Dielectric Strength			
Short Time			6.00
Step by Step			10.00
Power Factor and Dielectric Constant at 60 Cycles,			
10^3 or 10^6 cycles per frequency			15.00
2nd Sample			12.50
Each additional sample			10.00
Volume Resistivity—Insulation Resistance			5.00
Thermal Conductivity (Mean Temperature 80° F.)			25.00
Mold Shrinkage			15.00
Cost of machining and preparing samples			
Rate per Hour			1.75

The cost of molding test specimens will depend on the tests required and is based on a rate of $2.00 per hour.

NOTE: The per sample charge on the first eleven items includes five specimens on each test.

Standard discount given for quantity testing.

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TABLE XIII.—EFFECT OF MOLDING PRESSURE ON PHYSICAL PROPERTIES OF KRAFT-PAPER PHENOLIC LAMINATE

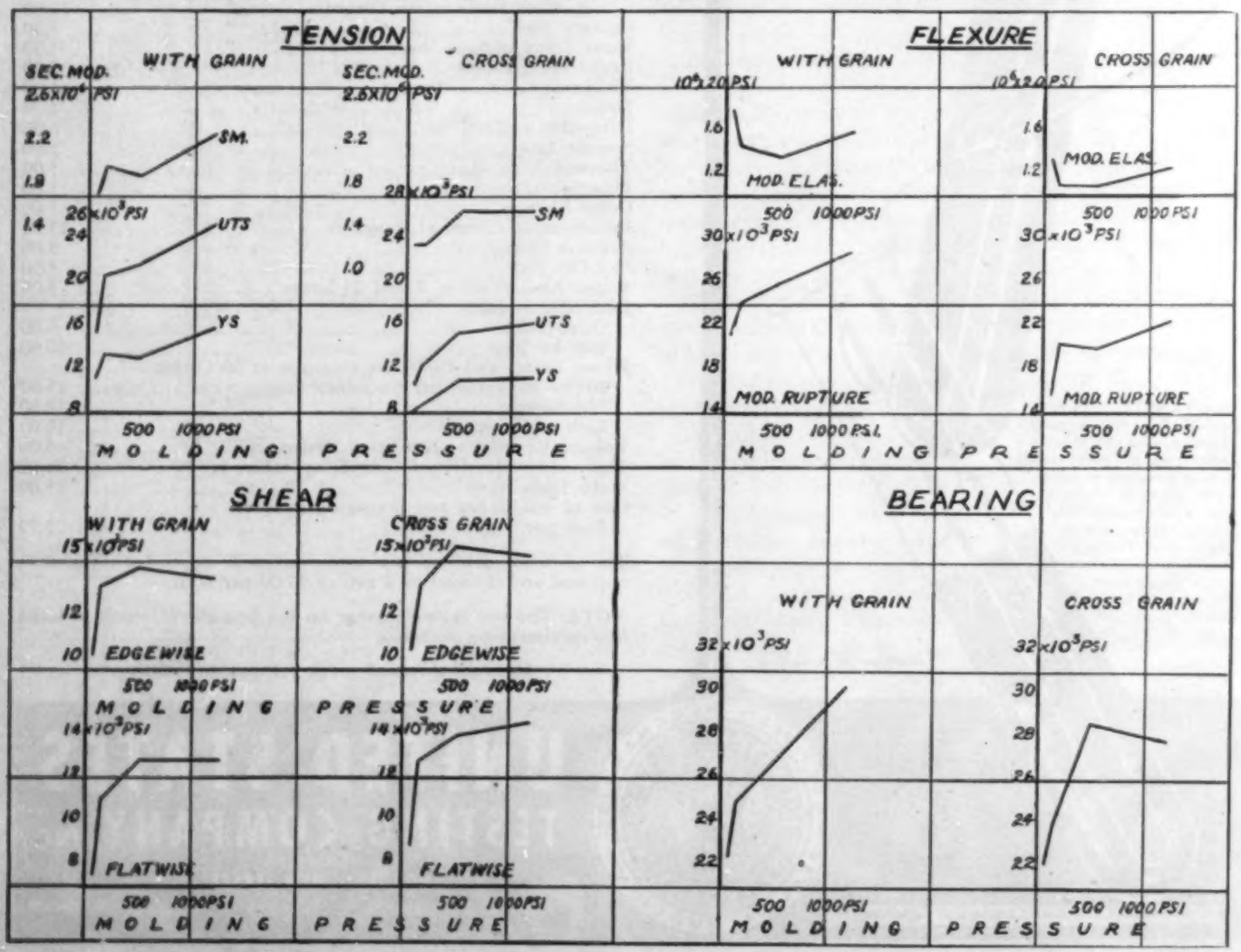
Molding pressure			Tension			Flexure		Shear		
			Ultimate strength	Yield strength	Secant modulus	Modulus of rupture	Modulus of elas.	Flatwise strength	Edgewise strength	Bearing strength
p.s.i.			p.s.i.	p.s.i.	p.s.i. × 10^6	p.s.i.	p.s.i. × 10^6	p.s.i.	p.s.i.	p.s.i.
75	W.G.	Max.	16,400	11,700	1.793	21,950	1.345	7,730	10,650	22,900
		Min.	15,500	11,600	1.662	21,020	1.290	7,490	9,670	21,550
	C.G.	Max.	11,000	8,400	1.365	16,350	0.956	8,940	10,700	22,450
		Min.	10,500	8,020	1.162	15,500	0.942	8,730	10,220	22,100
150	W.G.	Max.	21,050	14,020	2.003	24,800	1.475	11,180	13,420	25,390
		Min.	20,500	13,250	1.893	23,800	1.385	10,940	13,350	24,300
	C.G.	Max.	13,100	8,810	1.259	20,300	1.110	12,880	13,550	25,100
		Min.	13,050	8,790	1.256	20,300	1.020	12,510	13,150	23,200
500	W.G.	Max.	22,000	13,500	1.929	26,300	1.378	12,950	14,150	28,500
		Min.	21,800	13,000	1.860	25,800	1.354	12,640	13,980	24,800
	C.G.	Max.	15,800	11,390	1.629	20,340	1.099	14,150	15,220	29,300
		Min.	15,430	10,750	1.536	20,100	1.088	13,750	15,220	28,450
1200	W.G.	Max.	26,200	16,950	2.421	29,300	1.580	12,950	14,020	31,550
		Min.	25,200	15,300	2.179	28,500	1.570	12,580	13,520	29,000
	C.G.	Max.	16,400	11,080	1.583	22,600	1.220	14,620	14,950	28,900
		Min.	15,900	10,820	1.546	22,200	1.210	14,530	14,590	26,950

nated materials. It is to be expected that the high-strength molding materials would exhibit similar variations and trends, except in the case of directional properties where they will be less affected by grain, but more affected by the design of the mold. It is probable that effects of repeated stresses, molding pressure and fatigue would be accentuated in the case of molding materials because of less uniform distribution of resin and reinforcing agent, leading to the greater risk of localized weak points in the structure being molded.

Summary

1. The properties of the plastic materials tested improve at low temperatures and deteriorate at high temperatures. The materials having the best properties were found to be high-strength paper and special glass-fiber-cotton laminate. At 160° F. the important properties of these materials are:

20—*Effect of molding pressure on physical properties of kraft-paper phenolic laminate (see Table XIII).*



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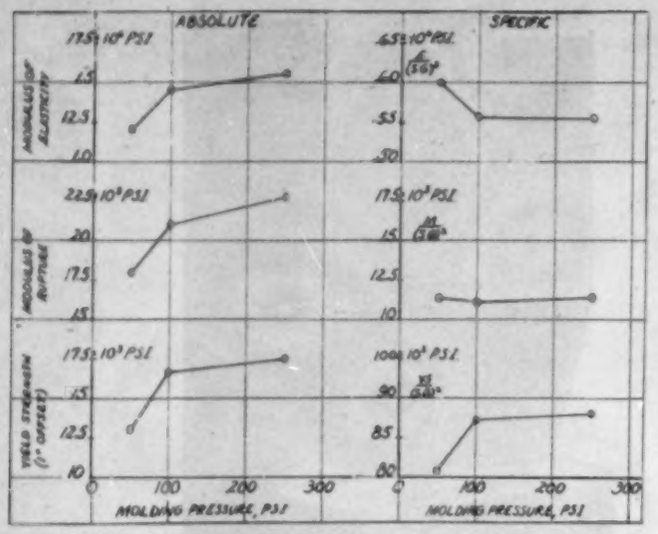

21—*Chart showing flexural strength versus molding pressure for high-strength-paper phenolic laminates*

	High-strength paper, p.s.i.	*Glass-cotton laminates, p.s.i.*
Ultimate tensile strength	18,100	24,700
Ultimate compressive strength	18,500	27,300
Ultimate compressive modulus	1.31×10^6	2.22×10^6
Modulus of rupture	20,400	39,000
Bearing strength	23,800	18,000

2. The high-strength paper material is essentially isotropic whereas the glass material has greatly reduced properties at 45°. At 45° the reduction in tensile strength is relatively greater than for plywood.

3. Plastic materials have superior vibration damping qualities; however, the dissipation of vibrational energy raises the temperature of the material. In determining the fatigue strength of plastic materials on the Krouse-type constant-strain machine, a correction must be made for the decreased modulus of elasticity resulting from the increased temperature of the specimen.

4. The glass material and some fabric base laminates deteriorate under the action of repeated stresses. Failure of fabric base parts in service indicate the importance of further investigation of this problem.

5. The high-strength paper material has poor elongation (less than 2 percent before fracture) and bearing specimens frequently fail in tension, indicating susceptibility to stress concentration.

6. Physical properties substantially equivalent to those obtained at high pressures can be obtained with molding pressures down to 150 p.s.i. Uniformity can be assured by adequate care and control.

TABLE XIV.—COMPARATIVE SPECIFIC STRENGTHS OF ALUMINUM ALLOY AND LAMINATES

Property	*Aluminum alloy 24ST*	*High-strength paper laminate At +76° F.*	*High-strength paper laminate At +160° F.*	*Glass laminate At +76° F.*	*Glass laminate At +160° F.*
Specific gravity	2.8	1.38		1.68	
Ultimate tensile strength	22,100	20,100	13,100	23,500	17,400
Ultimate compressive strength	22,100	16,400	13,400	16,800	16,250
Modulus of rupture	7900	14,900	10,700	21,500	21,100
Modulus of elasticity × 10^4	0.409	0.707	0.495	0.510	0.438

7. Although physical properties are lower at elevated temperatures than at room temperature, strength-weight ratios based on values for 160° F. show advantages for high-strength paper over 24ST aluminum alloy in applications where the material is critical in bending or buckling.

Acknowledgment

The author wishes to acknowledge his appreciation to R. W. Goldsmith, E. Hemming, Jr., and W. C. Renwick, who assisted in obtaining the data presented in this paper.

Footnotes

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Molding plastic-plywood

(*Continued from page 77*) sketch, Fig. 5. This will provide reinforcement for the concentrated stresses of attachment devices. The final joining of the trailing edge may be a subsequent bonding operation after machining the extremities into an accurate scarf. Such a construction can be made only with omnidirectional pressure, and a smooth streamlined exterior is imperative.[20]

There are many other applications of pressure exerted by flexible bags and tubes in plywood production. They are found in both primary and secondary gluing. In general, the cost of bending flat plywood into simple curved shapes, where construction requirements permit, is considerably less than that of corresponding fully molded plywood. Such flat plywood, if bonded with a phenolic resin such as resin film, can be steamed to soften and make it more ductile, then bent between forms or dies, and finally dried while firmly held in its curved shape. Some concentrated stresses may occur from the bending, but their significance can be anticipated. In the final analysis, monocoque and semimonocoque shapes can only be made by the molding processes, and, in this field, flexible-bag molding abundantly justifies its development. Many variants in this technique may be expected as experience widens in this field.

Molds or matrices

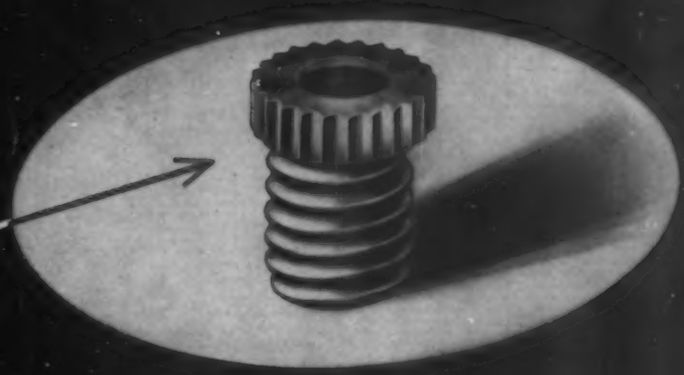
Most molds used in this flexible-bag process are of wood, plywood or sheet metal, although some have been made of cast metal, plastics and concrete.

The solid wood mold is easily made of laminated and cross-laid lumber layers, It is relatively inexpensive but bulky and can easily be altered to accommodate changes in design. However, wood molds are wasteful in absorbing heat and require replacement from time to time. Some authorities consider 50 "cooks" an average expectation from a wood mold.

Plywood molds have the same exterior contour as the solid-wood mold. In fact they are usually made by reducing the size of the wood mold some $^1/_2$ to 1 in. in a direction everywhere perpendicular to the curved surface, and molding a thick plywood shell on the reduced mold. This shell may be used open, or it may be braced and enclosed as may be found necessary to support, rigidly, any pressure which may be applied. Such plywood shell molds have the obvious advantage of being light in weight and tough, of providing long life and of

NOW IT CAN BE DONE!

A Molded-in One-Piece Insert Can Be Replaced Without Special Tools or Damage to the Material



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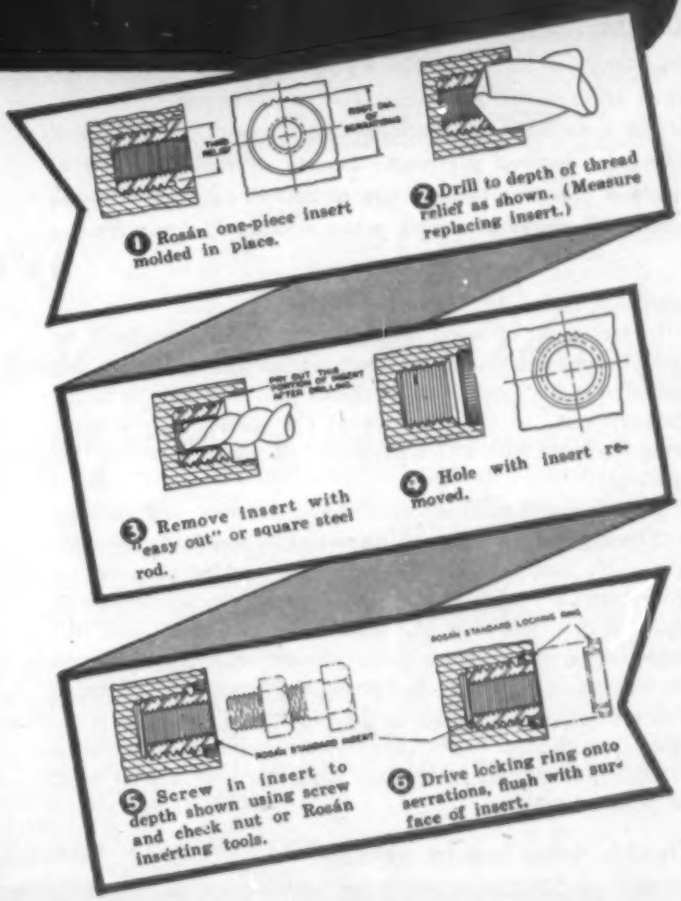
The Rosán One-Piece Molded-in Insert not only may be removed without disturbing the parent material, but it leaves a threaded, counterbored and serrated hole into which a standard Rosán Threaded Insert may be screwed and locked by the regular process of the Rosán Locking System.

The principle of the Rosán Locking System, which furnishes this solution to fastening problems, is very simple and ingenious. On the standard Rosán Insert, there is a serrated collar. The Rosán Locking Ring, which is serrated both inside and out, engages its inner teeth with the serrations on the collar while its outer teeth, or splines, broach their way into the parent material at the wall of the counterbore. The pressure of the surrounding material causes the Locking Ring to close in upon the collar enough to eliminate all tolerance and make a permanent, solid installation. The diagrams at the right show the method of removing the Rosán One-Piece Molded-in Insert and replacing it with a Rosán standard unit.

There is also the Rosán Molded-in Stud which is locked in the material, but replaceable like the Insert.

Manufacturers are invited to submit their fastening problems to our Engineering Department. No obligation. Write for full information and descriptive literature.


1 Rosán one-piece insert molded in place.
2 Drill to depth of thread relief as shown. (Measure replacing insert.)
3 Remove insert with "easy out" or square steel rod.
4 Hole with insert removed.
5 Screw in insert to depth shown using screw and check nut or Rosán inserting tools.
6 Drive locking ring onto serrations, flush with surface of insert.

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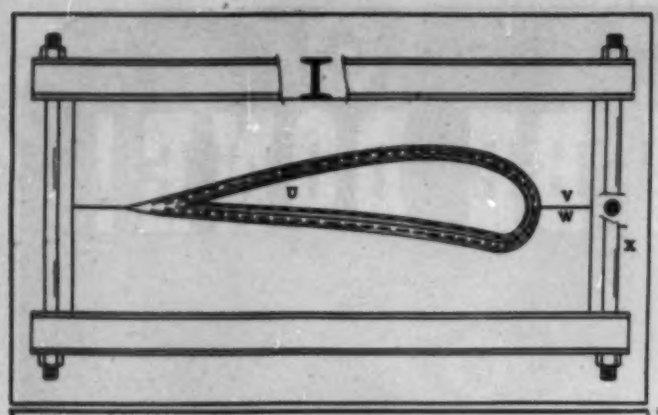

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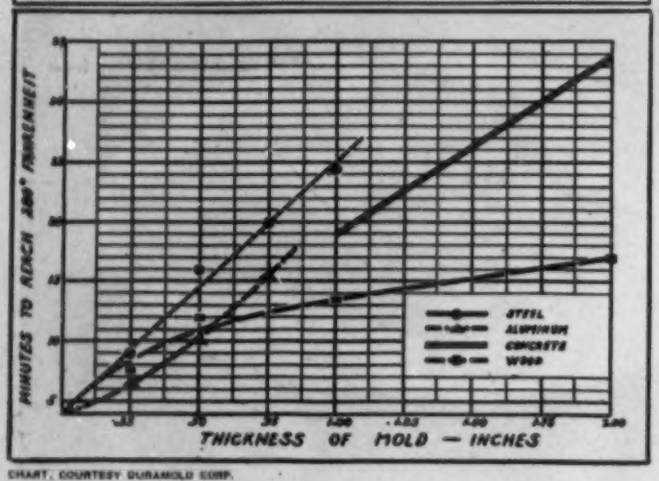

10

CHART, COURTESY DURAMOLD CORP.

9—Aileron molded with inside flexible bag. U, flexible bag inside of plywood, which presses veneer against concave surfaces of matrices; V-W, recessed matrices; X, strain rods holding matrices firmly together. **10**—*Time chart for molded plywood. Length of time required to reach a glue-line temperature of 280°F. on various types and thicknesses of molds, when making $^3/_{16}$-in. plywood*

absorbing far less heat than the solid wood molds.

In any mold of wood or plywood, the surface should be given a hard finish, both as a preservative and to prevent any adhesion of the inner layers of the molded plywood due to the "squeeze-out" of the adhesive at the joints. Many users wrap the mold with a thin paper or cellophane to reduce this tendency.

A sheet-metal mold is shown in Fig. 3 (lower-right sketch), and its type of braced construction can be noted. Such molds are costly and only justified when the molded plywood requirements are substantial. Design alterations are difficult to make in this type of mold. This thin metal mold, with stiffened edges, serves as one-half of the rubber bag, and it must be airtight in order not to neutralize the vacuum. Since, in this type of thin-metal mold, the heat of the autoclave is applied to both sides of the plywood, the bonding cycle can be considerably shorter in duration than when using solid wood or plywood molds.

Flexible rubber bags for molding

Satisfactory results have been obtained in the use of a fabric coated with a heat-resistant synthetic rubber. The use of the fabric adds durability since the bag is employed for flexibility rather than extensibility. This is available in various thicknesses, but it is desirable to select as thin a sheeting as will withstand the hard service to which it will be subjected. Thin sheeting will also facilitate heat transfer through the rubber, and overlaps and folds will be less serious. Some authorities prefer the use of natural rubber, without a fabric base.

The sheet rubber is cut to size, folded and cemented into the desired shape, either closed bag, open-end bag or blanket. Any edges at the closure ends must be reinforced to permit folding over and clamping. Vent connections with valve stems require reinforcing and cementing in place, with suitable provision against sealing.

It has been found that rubber will deteriorate less under the application of steam alone than when exposed to mixtures of steam and air, which has an oxidizing effect. Steam alone, under certain conditions, may raise the temperature too rapidly, before adequate pressure can be attained. Hence the relation of time, pressure, heat and rubber durability require careful adjustment to an optimum compromise.

In many cases approximately 50 "cooks" are the normal expectancy in rubber bags, while some authorities claim to get 100. This limitation in rubber durability has directed attention to some type of airtight enclosure that can be discarded after use. Study is being given to some type of paper or flexible plastic which may be used only once. The present developments in this direction give promise of a better flexible bag technique.

Adhesive requirements

There are several special features required of high-quality adhesives in bag molding, These are in addition to the normal requirements of extreme durability which are demanded in flat aircraft plywood. They are as follows:

1. The cure of the adhesive bond must be accomplished in a minimum of time, to permit economic and repeated cycles in the use of the mold, flexible bag and autoclave. This, from a practical viewpoint, limits the adhesive to one of the synthetic types of thermosetting resins.

2. Low temperatures are highly desirable to permit as long a bag life as possible. Steam-heated autoclaves function best at 230° F. and above.

3. Relatively long "flow" periods are important to allow slippage of every layer into final position during the pressure build-up and before final hardening. This can be accomplished by using a resin which remains plastic for a considerable period at 180° to 200° F. and begins to harden at 220° to 230° F.

4. Long assembly times are imperative, since the wrapping of complicated molds may require a matter of hours, during which the adhesive must not be tacky. This suggests a phenolic or fortified urea resin that can be predried after spreading to remove the tackiness and can be softened again to a flow stage by the proper degree of heat.

5. Veneer to be curved should be as ductile as possible to eliminate rupture or excessive stresses in bending. The initial warping of single-spread surfaces should be reduced as far as possible. The use of part alcohol as a solvent will meet these requirements.

Types of resin adhesives available

Three types of thermosetting resin adhesives, widely used in making molded plywood by the flexible-bag method are: *a*) phenol-formaldehyde-resin film; *b*)phenol-formaldehyde resin applied to the wood as a liquid; *c*)fortified urea-formaldehyde resin also as a liquid application.

In the case of simple constructions that can be assembled

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rapidly before surface drying, low-temperature urea-formaldehyde resins are sometimes employed. Their cure without heat is too slow from a practical standpoint, but it can be accelerated by heat at 100° to 150° F. In general, the durability and long assembly times of the phenolics make them preferable over the ureas, wherever conditions permit their use.

The use of a resin film affords the simplest technique where the curvature is not so complex as to require much cutting or folding of the film. It is merely laid between the veneers, which should have a moisture content of approximately 5 to 12 percent. The required temperature of cure is 280° to 300° F. and the relative length of the curing cycle is shown, for various types of molds, in Fig. 10. This chart is based on 3/16-in. plywood and will require some adaptation for other thicknesses. In the use of film, the amount of spread is uniform and any penetration of resin through the outer veneers is reduced to a minimum.

A liquid phenol-formaldehyde resin requires weighing, mixing, spreading and predrying, as contrasted with the dimensioning and interlaying of film but is adapted to complicated and monocoque curvatures. Most of these phenolics are available in dry powder form with excellent storage stability and can be mixed with water or alcohol or varying combinations thereof.

Alcohol-water solvents usually give the best results for flexible-bag molding. Double-spreading on both surfaces of each joint is advisable, and the amount of spread can be varied according to conditions. Predrying is necessary to avoid steam blisters during the cure cycle and to regulate flow and surface penetration. The cure of phenolic liquid resins can be according to the graph in Fig. 10, if a temperature of 280° F. is available. Many of the phenolics will also cure at 240° F. but under considerably longer cure cycles, which will vary with the mold types shown in Fig.10. Some of the phenolic-resin adhesives of liquid types can be combined with special catalysts to bond at temperatures of approximately 180° to 200° F. Great care must be exercised in the selection of such catalysts, because of their effect on workable life, assembly time, flow characteristics, wood structure, etc.

The third option, as an adhesive for flexible-bag molding, is a fortified urea-formaldehyde resin. This requires special catalysts, which cause the ureas to approach some of the qualities of the phenolics. While the durability is appreciably less than the phenolics, it will permit long open-assembly times and will withstand limited boiling tests. Its temperatures of cure are lower than most phenolics, and time requirements are shorter. Its flow characteristics are better than the phenolics under some conditions, but it cannot be used with alcohol solvents. On the other hand, the urea adhesives, due to the presence of catalysts, exhibit a gradual change in properties on the coated veneers, in contrast to the corresponding stability of the phenolics.

The present tendencies among leading bag molders seem to favor the phenolics, except for such applications as deep laminated rings, where heat penetration is slow.

Conclusions

Monocoque and semimonocoque plywood made by omnidirectional pressure is proving its adaptability in many aircraft and boat designs. The urgency of the war effort has not permitted the proper consideration of its utility for civilian products. Those who are most familiar with its possibilities feel that the war applications of such plywood are only the introduction to wider fields of usefulness for these unusual and efficient curved-plywood shapes. During the last ten years plastic-plywood has made tremendous strides, but the next decade holds even greater promise of plastic-plywood progress.

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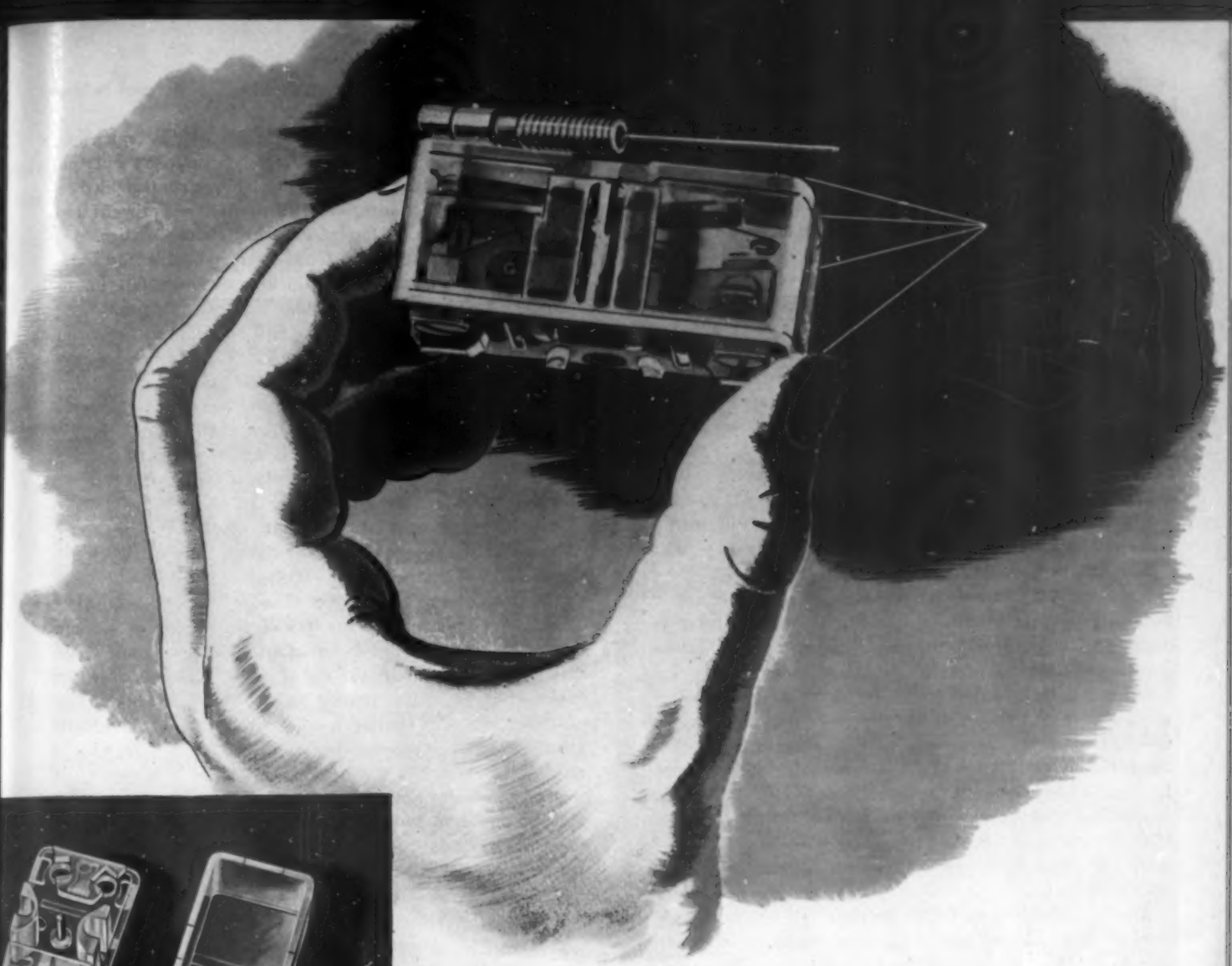
Polystyrene

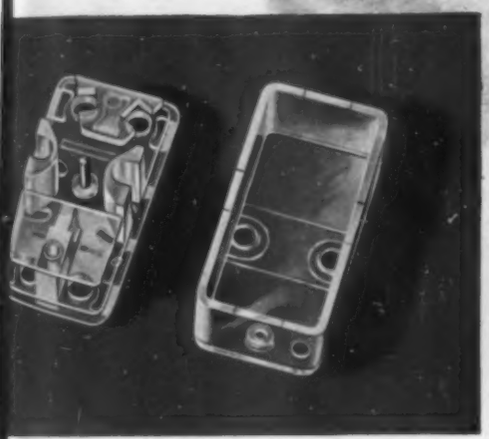
(Continued from page 81) changing conventional sprue positions and sizes in order to avoid severe streamline flow. Even better results are obtained when hot molds are used to cause relaxation of the oriented molecules before cooling.

Certain improved methods of shaping polystyrene have been developed in which undesirable orientation may be eliminated. When such methods were adapted to the production of polystyrene rods ranging in diameter from 1/16 in. to 6 in. and other shapes, a large business in polystyrene articles machined from stock shapes was created.

The first applications of machined polystyrene articles proved disastrous because many articles spontaneously crazed or cracked shortly after machining. To meet this problem, mechanically stabilized polystyrene rods, slugs and plates were developed which would not crack after machining or in subsequent service life. As a result of this and of the discovery of proper machining and finishing methods, it is now possible to produce polystyrene blanks and to machine them to any desired shape.

The importance of employing correct methods of machining and finishing polystyrene shapes cannot be overemphasized. It is essential in all machining or finishing operations on polystyrene that the surface temperature of the





STYRON SIMPLIFIES MOLDING OF TRANSPARENT CASE

Ease of fabrication ranks high on the list of outstanding Styron characteristics. By using this thermoplastic injection molding material, one cavity for each part is sufficient for producing the housing illustrated above. Faster molding cycles are also possible. Thus, through Styron, the cost of fabricating equipment is reduced, and production volume increased.

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Limit switches, specifically designed for modern machine tools, call for complete precision in both design and fabrication. To the limit switch manufacturers, the Square D Company, and to the molders, the Kampa Manufacturing Company of Milwaukee, this demand for accuracy pointed to Styron—Dow's transparent plastic used for the molded case.

Styron was selected because it possesses the electrical properties, heat resistance and dimensional stability required for precision performance. Its outstanding insulating qualities eliminate any tendency toward carbonization or carbon tracking from the small arc produced at the contacts. In addition, Styron's complete transparency permits visual inspection of the mechanism and, at the same time, permanently seals the unit against tampering.

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plastic should not be raised above 180° F. If the material is overheated, there is serious danger of subsequent cracking even if gumming does not occur. By avoiding all excessive friction, aiding chip clearance and sometimes using a coolant, no difficulty is encountered and excellent results are obtained.

It must be pointed out that gasoline, kerosene and other oils will dissolve polystyrene and therefore under no circumstances should oil be permitted to come in contact with this plastic. Hands and rags must be free of oil. When a coolant is desired, soap and water may be used. To prevent rusting, a water solution of Solvac 100 M special, a Socony product, is advantageously used.

The following methods of machining are recommended, based on the fact that most trouble encountered is due to overheating caused by friction or lack of chip removal.

Sawing—A 9-in. circular hollow ground saw, $^3/_{32}$ in. thick to avoid vibration, has been found satisfactory. When cutting material less than $^1/_4$ in. thick, a saw with 12 to 15 teeth per inch is used, and for heavier sections one with 10 teeth per inch. No heating occurs if the saw is operated at 1850 r.p.m. with a coolant running through the kerf.

Drilling—Hard drills with polished or chromium plated flutes, possessing a large clearance with a low rake, are desirable. When drilling "through" holes, a neutral rake or slow helix is used to prevent "breaking through"; for blind holes, a fast helix is preferred. In most instances, coolants are used. Drills are available with a central hole through which the coolant is pumped into the tip, whence it flows back along the flutes. When drilling small holes, the drill must frequently be backed out to clear chips.

Turning—Polystyrene can be readily turned. Best results are obtained by using a sharp tool with only a slight rake and large clearance. A coolant is usually used for internal boring.

Milling—It has been found that special cutters with low side friction are desirable. In some cases, a coolant is necessary. If it is not used, an air nozzle should be used to blow away chips.

Threading and tapping—In all threading applications, a coarse pitch without a sharp thread is preferable. Oversize taps are used to create the necessary clearance demanded by the difference in coefficient of expansion between polystyrene and metal if metal screws or bolts are used. If high stresses are to be applied to a screw or bolt, it has been found expedient to use threaded metal inserts or fittings.

Assembly—Polystyrene should never be deformed more than $^1/_2$ percent and preferably not more than $^1/_4$ percent. Therefore, screws tapped into styrene should not be more than hand tight. A cement is used where the screw must be held against vibration although in some cases a cork or rubber washer will hold the screw tight. When a flat panel is fastened into place, great care must be exercised to keep the holding channel or frame flat and thus avoid bending the panel. Although a channel is preferred to bolting, if bolts are used it is important that they be so placed that the load is equally distributed and that all of them are under the same tension. If a cork or rubber washer can be used, it is easy to obtain uniform bolt tension. If tension is too great, stresses greater than 1200 p.s.i. will be set up under the bolt head and cracks are likely to start about the hole. In general, all sources of stress concentration such as those caused by direct clamping, riveting or reentrant angles should be avoided.

Polystyrene strips may be welded together or about coils by heating to 230° F. and pressing. Rod may be bent to any shape by preheating to 230° F. and cooling in position. Necessary machining operations should be performed before heating and bending.

A polystyrene cement is available for use in cementing sections, fastening coils to coil forms, or making seals on high frequency electrical equipment. This cement applied in liquid form to the surfaces to be joined, welds smooth surfaces of polystyrene with no loss of electrical characteristics.

Oriented polystyrene sheet has been available for some time in continuous rolls with thicknesses from .001 in. to .020 inch.[4] This material† does not resemble ordinary polystyrene, since it is not brittle and can be stretched from 7 percent to 50 percent before break. The Mullen strength of this polystyrene sheet is comparable to that of cellophane. It is used in stamping operations to produce washers, spacers and the multitude of other small punched shapes, and is also employed for such applications as condenser manufacture and cable wrappings, where it replaces hard rubber, mica and phenolic-coated paper.

It is apparent from Table I that polystyrene will satisfy all the requirements necessary for the ideal dielectric except that of high heat resistance. It should not be used where service temperatures are higher than 75° C. or 167° F. because above this temperature its electrical properties are no longer constant. It has to be admitted that this one characteristic severely limits the use of polystyrene, but recently engineers have been designing around this limitation. For example, instead of using a solid coil form, styrene slabs are cemented to the coil, thus giving a lighter unit with a much greater chance for heat dissipation. The material's use as stand-off insulators, cable heads and spacers, high voltage bushings and shields offers little difficulty. When used for low loss dielectric plates and insulating film, the parts should be positioned away from sources of heat and exposed to air circulation if possible.

The usual method of applying styrene consists of first designing to the properties of the material and then submitting the design to a manufacturer of such stock shapes as sheet, rod, tubes, plates or fiber. If it appears that the application is sound, a trial order is placed with the supplier who will machine the desired articles from styrene blanks without the delay or expense of obtaining a die or mold. The articles are then tested in trial installations or, in some cases, under extensive service conditions. Changes in design are made when necessary, without undue loss of time, and the more satisfactory articles are put into service. At this point, if the design becomes "frozen" and large quantities are desired, it is sometimes cheaper to have the parts molded and a die or mold is constructed. The delay in obtaining the mold and initiating production need not hold up the prime production, for a sufficient number of machined parts can be ordered to cover this period. In some instances, it will be desirable to machine articles even though it may be cheaper to mold them in order to insure that the articles will have the desired properties and perform satisfactorily.

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† Marketed under the trademark Polyflex.

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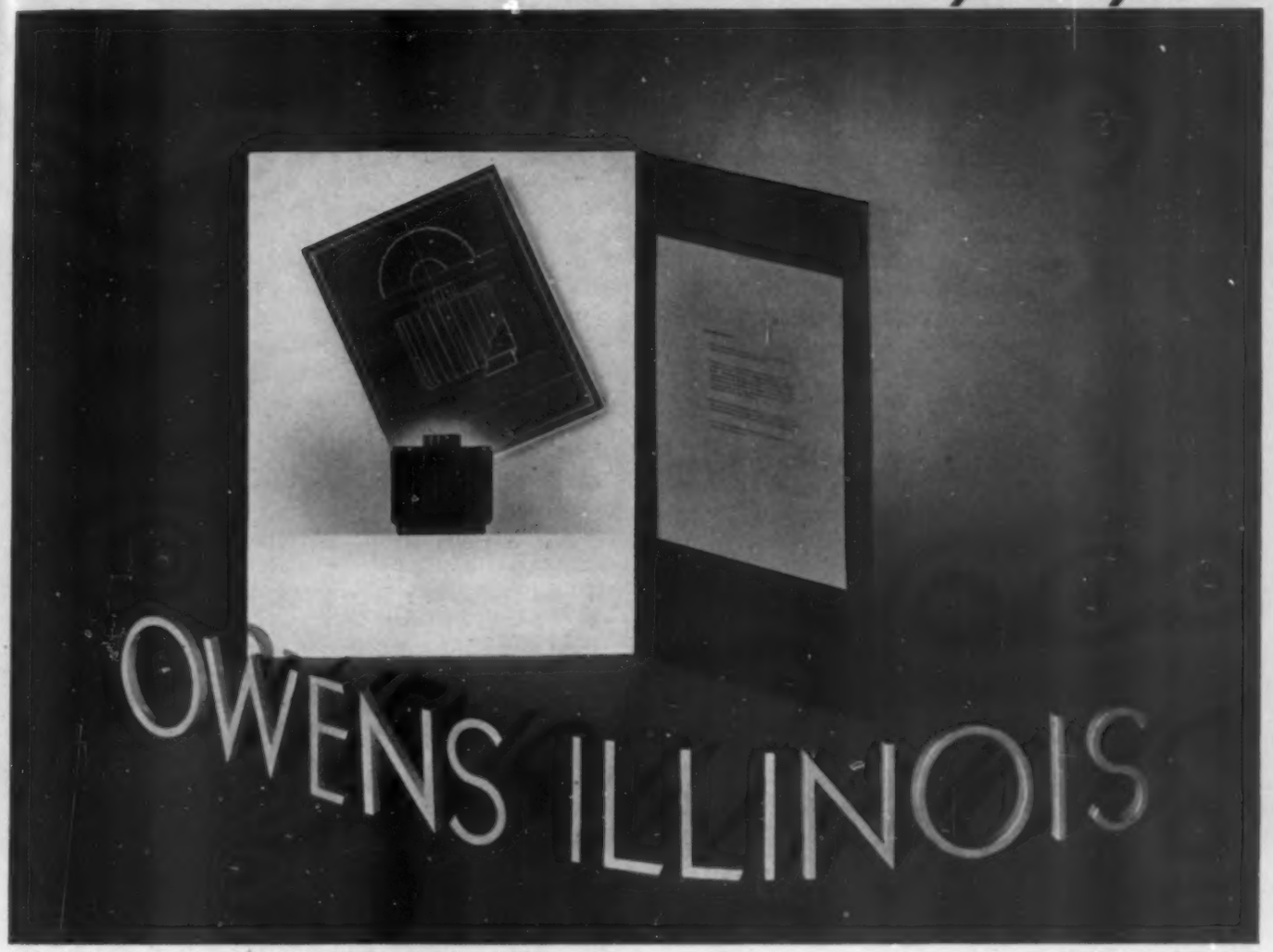

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PLASTICS DIVISION . . . OWENS-ILLINOIS GLASS COMPANY, TOLEDO, OHIO

Laminated phenolics

(*Continued from page 87*) on the shape involved and the direction of the molding pressure. These values range between plus 10 percent and minus 20 percent of the average values for plate stock.

Comparison of mechanical properties

Table I gives a comparison of the mechanical properties of paper and fabric laminates, woods and metals. The average values listed here for the laminates are those determined in the directions of their greatest strengths.

In mechanical applications laminated phenolics show their greatest strength in flatwise compression and the ratio of their compressive strength in this direction to their specific gravity is greater than that of structural steel. The modulus of elasticity of laminated phenolics depends upon the type of load and upon the direction in which it is applied. However, in all cases it is less than that of metals.

In some applications where electrical insulation is not a factor the greatest advantages of laminated phenolics are their light weight and resiliency. Figures 2 to 11 illustrate the characteristic curves for typical laminated phenolics. The test data for the curves 2 to 9 were determined at room conditions. Figures 10 and 11 show the effect of temperature changes on the strength. The general shapes of these curves are typical of the corresponding curves for the other grades.

Handwheels for destroyers

(*Continued from page 61*) automobile license plates; domestic utensils like serving trays, plates and bowls, and a number of items for the war program.[1] Consequently Mr. Newell, who knew something of this material, invited us to submit samples which were tested at the Bath works and stood up well under the ordeal. Next step was to convince the Navy Department of the worth of the plastic replacement, and for this a finished wheel molded of the material was necessary.

Three men at our plant were chosen to work on the project with Engineer Towne and Commander V. W. Grady, Navy representative in charge of destroyer construction at Bath: Chief Engineer W. H. Randall, Chemical Engineer E. E. Sawyer and Superintendent G. R. Johnson of the Plastics Division. A design was finally agreed upon, and with $1500 put up by the Bath company, a die for a 14-in. wheel was built during the summer of 1942. From this mold on Oct. 23 came the first sample wheel, which was promptly dispatched to the anxious shipbuilder, who examined it, found it good, and forwarded it to Washington.

Impatient to know the plastic handwheel's fate, and to end the suspense, President Newell packed another sample in a trim little case and himself carried it to Washington, where he displayed it to a group of Navy men. After discoursing at length on the merits of the plastic wheel, and handing it over for serious eyeing and hefting, he dispelled the last vestiges of scepticism by slamming it hard on the concrete floor, from which, undamaged, it bounced with obliging alacrity. Hustled off for a routine of tests, the wheel, equipped with either a malleable iron or cast bronze hub, was in due time approved for Navy use, and we went into production.

First of all, designs for a series of wheels ranging from 5 to 24 inches in diameter were drawn up, plans made for the construction of preform dies and curing molds, and delivery schedules agreed upon with the Bath company. Application was promptly made to the WPB for the release of sufficient metal for preform and curing molds and drying machines. The requisite priority assistance was granted, and within a relatively short time the steel was on hand and the work underway.

The molding of the handwheel followed the procedure developed for other articles composed of preformed fibrous plastic material: a pulp incorporating phenolic resin was preformed to approximate shape and subsequently cured in a second operation. Preforms in this case were suction molded from a mixture consisting of a long-fibered pulp and a phenol-formaldehyde resin. When molded, the preforms corresponded in size and shape to the completed wheel. A carefully controlled drying process followed, after which the final curing of the preforms took place in a conventional compression mold under the necessary heat and pressure. The metal hubs were loaded in the mold as inserts and the only finishing operation required was the removal of the flash.

A reduction in sectional thickness and an increase in density constitute the only physical change induced in the preforms by the application of heat and pressure. The great strength of the finished wheel is a result of compacting the inter-felted fibers and cementing them together with the cured phenolic resin.

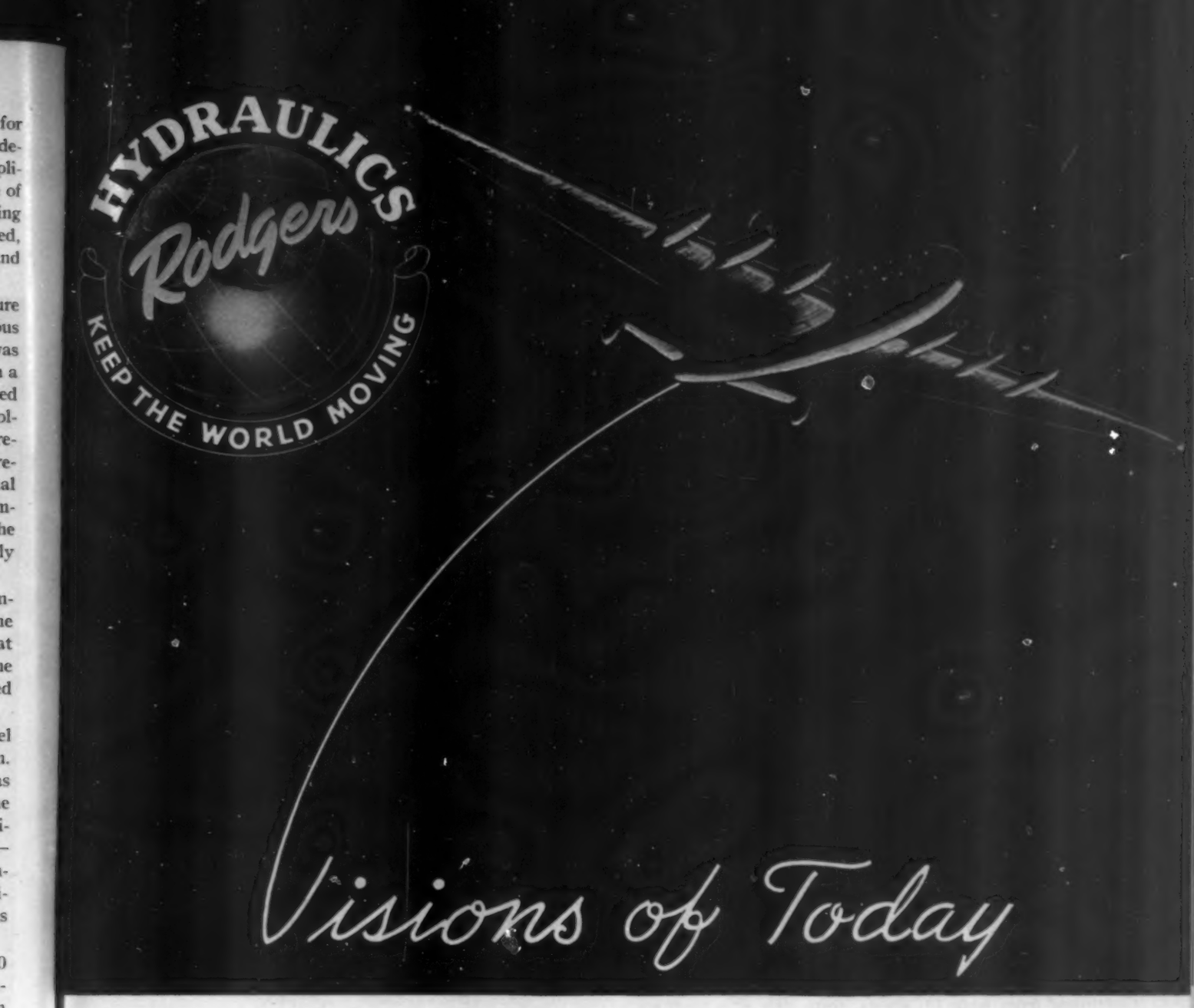
The shipbuilding company feels that the plastic handwheel has several distinct advantages over a wheel of aluminum. The conserving of the latter metal has already been noted as amounting to 1960 lb. per destroyer. Since the weight of the plastic wheel is approximately 80 percent of that of the aluminum, a direct saving of weight per ship amounts to 410 lb.—a figure which, though it may seem unimpressive when compared to the total weight of the vessel, is none the less significant when speed and maneuverability are recognized as prime destroyer requisites.

As a conductor of heat, the resin fiber wheel rates 1000 times below the aluminum, an advantageous factor in handling those on high-pressure, high-temperature steam lines, in particular. In addition, it is a non-conductor of electricity. Its abrasion resistance has been found superior to that of aluminum. Equipped with a bronze hub, it will not be corroded by sea air and salt water when used above deck. When tested to failure by the Navy, the plastic wheel still retained enough basic strength to operate its valve in emergency, though a section of its rim had been broken away.

A point not considered of great significance when the new wheel was developed is the fact that it can be molded in a variety of colors which, because they are integral with the material, won't wash off or wear off. When the Navy instituted a schedule of colors to differentiate the function of different piping systems and valves, the importance of this possibility of the plastic wheel became apparent. In emergency, when the life of the ship and her crew members may be at stake, a man can be instructed to open or close handwheels of a certain color when there is no time to explain to him the functions of the valves they control.

Other desirable characteristics of the resin fiber wheel are those which relate directly to its manufacture rather than to its efficiency aboard the destroyer. In the first place, the shipbuilder now has at his disposal for other purposes the foundry space and facilities formerly given over to the production of the aluminum wheels or wheels of other metals. Second, women have been trained to work on the plastic

[1] MODERN PLASTICS for October 1941 carried an article on this development under the title, "Molded pulp resin products."



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Buy U.S. War Bonds and Stamps!

AT THIS CRITICAL MOMENT of our history, Americans are called to be creators, the makers of a new order of civilization. Every individual must play his part with keenness and enthusiasm, and every common task must make some contribution to a United Victory. It is not enough to gaze in wonder at the latest inventions of the mind of man. We must look with prophet's eyes beneath the surface of things, and beyond the events of the moment to the things that are to come. Thoughtful people everywhere are looking to the future.

Today, the aviation industry has found it both possible and practical to use plastics and plastic ply-wood for many of its needs. Within the range of immediate possibilities are huge airliners, swift, sleek and strong, manufactured almost entirely of plastic materials. These huge airliners will be able to double their freight and passenger capacity, at speeds beyond our imagination, and at greatly reduced operating costs. Safety will be an important factor in these new airliners of the sky.

Tomorrow, when the critical days are over, and Victory is assured, Rodgers Hydraulic Moulding Presses will be available again.

Today, we are devoting our entire resources to the overwhelming defeat of the Axis and their systems of barbarous oppression. Rodgers Hydraulic Inc., St. Louis Park, Minneapolis, Minnesota.

Rodgers HYDRAULIC Inc.

wheels, thus releasing for other and heavier jobs a section of the country's dwindling supply of experienced foundrymen and steel workers. Third, machine tool time is saved because the new wheel is finished when it is taken from the mold, whereas a metal wheel requires a considerable amount of machine work after casting. Finally, the development of the plastic wheel has disclosed the possibility of hub simplification which will materially reduce the quantity of wheel styles in all sizes which formerly had to be kept on hand.

From the point of view of man-hours saved by converting these handwheels from aluminum to a plastic material, the following data are pertinent: approximately 727 man-hours were required in the aluminum foundry and in the machine shop to complete the wheels necessary to fit out one destroyer. To manufacture and finish an equal number of plastic wheels takes only 444 hours, of which 128 hours represent work done by women. Thus the total saving of hours of labor is 282 per destroyer, or 410 if male labor alone is considered. On a percentage basis, the saving in hours worked (by both men and women) is 39 percent, or some 35 eight-hour working days—a considerable factor in times when speed is so essential.

Although the contract with the Bath company is the only one presently undertaken, there is reason to believe that this type of handwheel will be approved by the Navy for ships other than the destroyers now being so outfitted. In view of the greatly enlarged fleet which Director of War Mobilization James F. Byrnes recently informed Admiral Tojo and other interested parties that we would build within the next year, it is likely that 1944 will see thousands of these fibrous plastic handwheels going down to the sea in ships.

Credits—Material: Kys-ite, based on Durez phenolic resin. Molded by Keyes Fibre Co. for Bath Iron Works Corp. Curing molds by Atlas Tool Works.

Post-forming

(*Continued from page 70*) sheets, tests were run by the Pittsburgh Testing Laboratory and several other similar concerns. According to the results obtained by the laboratory (Table I) there is no greater variance in the reformed sheets than in the flat sheet stock. Also, no change in moisture absorption was indicated.

While the process is described as one of the greatest simplicity, strategic materials are necessary to the production of laminated sheets and the full importance of this molding process is not expected to be realized until the country is at peace. However, the company has found that this post-forming method can be applied to the softening of molded pieces. In this connection it is expected to be helpful in reclaiming parts that otherwise might be rejected.

The process has been turned over to the Government for experimental work in connection with various possible wartime applications, and it is being made available by license to manufacturers engaged in war production. Products made by the new method have been examined closely by experts from the Army, Navy and war industries. It is expected that the process will be of value in reducing weight and saving strategic materials in the production of planes, tanks and other military equipment, and that it will permit numerous new applications of plastics. In the postwar era this development may effect a marked change in the manufacture of furniture, electrical supplies and building materials.

The future of injection

(*Continued from page 90*) die casting process adaptation described above. Here the container is placed in a chamber which is an integral part of the molding machine. The material then is forced through a sprue or sprues into the mold.

Because the material is sealed in the container during preheating, no volatile elements are lost during the early stages of the process, and large amounts of plastics may be safely and uniformly prepared for injection. Undoubtedly steering wheels, basins, bathtubs, even coffins may be rapidly and successfully molded by this method. Since present experiments are being carried out on exceptionally large, heavy equipment hitherto considered too expensive to be used in connection with plastic molding, the perfection of the container method of injection well may open up a whole new engineering field in connection with the design and manufacture of plastic injection machines. It will certainly be a stimulus to the material suppliers to produce powders which will have a minimum warpage and shrinkage, less odor and a greater surface hardness to suit the many new plastic applications which the container process envisions.

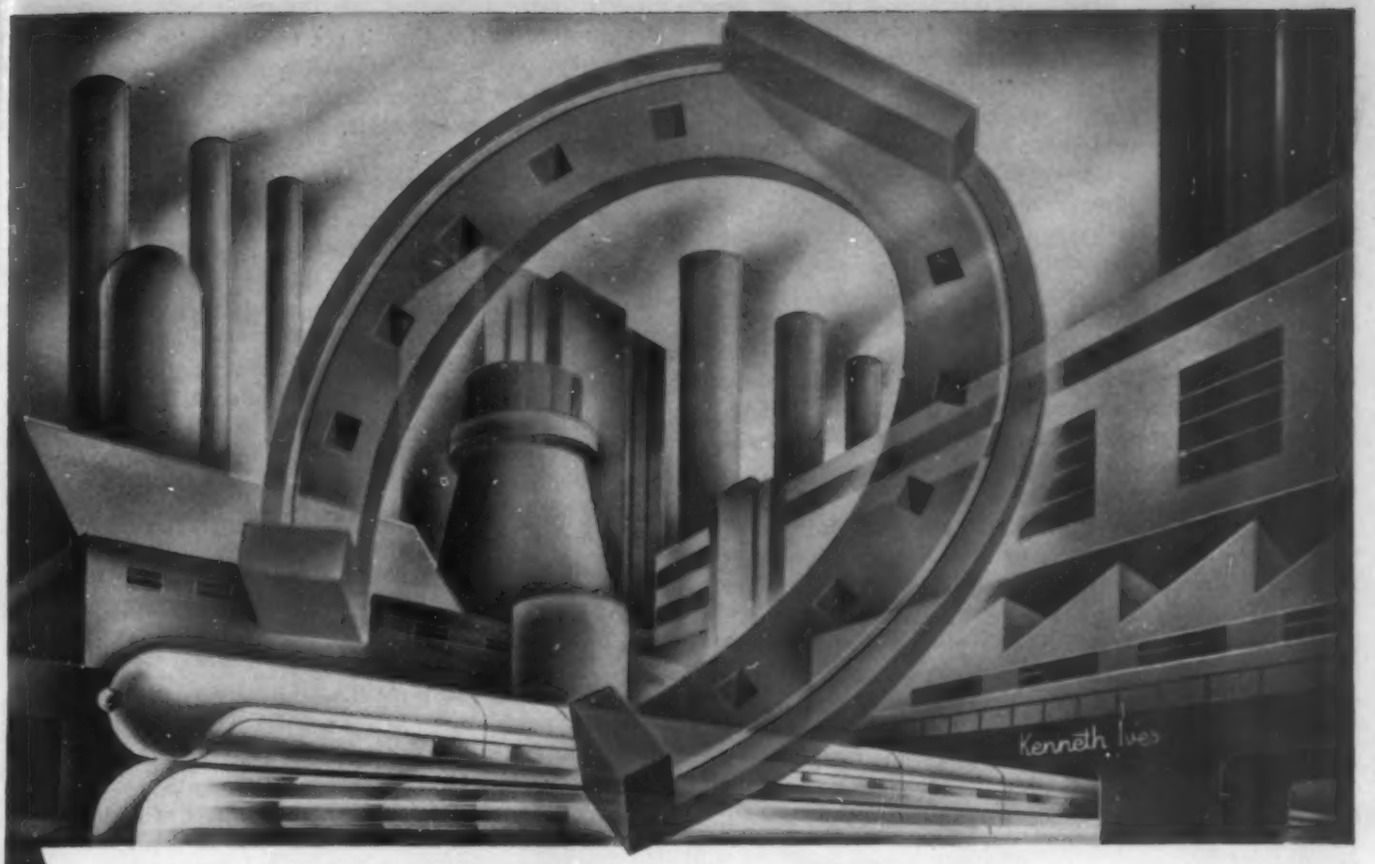
Changes likely in present injection machines

Other research programs are centering around variations of the present injection machines. Conventional machines certainly will be enlarged and refined to meet future injection requirements. Some of the present horizontal machines may well be offered in vertical models for molding articles requiring careful placing of inserts such as airplane steering wheels, carburetors and distributors, and housings of various kinds. The injection cylinder may be placed so that it will inject along the parting line of the mold as in conventional machines already available, or the heater may be mounted to inject through a sprue at right angles to the parting line. Such vertical machines well may be found in large numbers in future molding plants. The die closing mechanism will be concealed below floor level; the parting line of the mold will be waist high; the hopper fed from an air conditioned drying and storage room on the floor above.

A new low-pressure heater has been put into production which may have considerable influence on the developments of future injection machines. A standard 8-oz. machine has been doubled in capacity by merely increasing the diameter of the heater. This change results in thinner walls and more efficient heat transfer to the material and naturally lowers the pressure because of the increase in plunger size. So long as the material is sufficiently plastified, extreme high pressures do not appear to be absolutely necessary for successful injection molding of all thermoplastics. A development of this type could have widespread repercussions, both favorable and unfavorable, on future injection machine design. Conceivably it could result in the appearance of a highly simplified, lower cost injection machine capable of producing tomorrow's telephones, steering wheels, sporting gunstocks, sewing and adding machine housings, etc., at new low costs. If special ultra-efficient heaters were designed to convert numbers of present 4- and 8-oz. machines to 8- and 16-oz. capacity, the fact that present equipment will not suddenly become markedly obsolete also might be a large factor influencing the design of future machines and the plans of many molders as well.

More radical changes in machine design coming

Other programs of development are concerned with more radical changes in model and design than merely enlarging



You Don't Know How Lucky You Are

. . . Lucky that medical directors and safety engineers are doing the fine job they are in keeping limited man-power effective and productive. You can't see the man-hours they save . . . but they are there in the form of production that might have been lost . . . but wasn't.

One such job, featuring a new product, was done in the Durez Plastics and Chemical plant by effective teamwork between the safety and medical departments. The problem they solved was one of industrial dermatitis due to exposure to phenol-formaldehyde resins. The product they used was Tarbonis Cream.

They were so satisfied with results that they wrote users of Durez products:

"The Durez First Aid Department has tried various methods of controlling or curing this dermatitis over a period of twenty years. A treatment using Tarbonis Cream after a thorough cleansing has been found the most effective, and has practically eliminated dermatitis from the Durez plant."

Here is a job well done. A fine example of what medical directors, safety engineers, nurses, and first aid workers accomplish when they get the full cooperation and the tools they must have to do their vital work . . . already so well begun.

Based on experience such as the above is a *"Planned Procedure"* especially effective in dealing with chemical irritants as is adequately proved by the experience in the Durez plant.

If occupational skin irritations are costing your plant lost efficiency, lost man-hours, and lost production, write for full details of this program.

Listed below are a few, less than one per cent of the total number, of companies in one or more of whose plants Tarbonis Cream is now in use.

THE TARBONIS COMPANY
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FIRESTONE TIRE & RUBBER • GENERAL ELECTRIC • GENERAL MOTORS • NASH-KELVINATOR • WAYNE-BENDIX

Tarbonis
cream

FOR INDUSTRIAL SKIN IRRITATIONS

and refining present equipment. One project involves the use of a combined screw and plunger principle. During the first part of the cycle the plunger-screw revolves, forcing the material from a feeding or preheating chamber into the injection or pressure chamber. The injection then is caused by an actual forward movement of the screw itself.

Other projects involve various methods of agitating the material during the softening process to speed the transfer of heat evenly to all parts of the material charge. One development involves straight extrusion from an intermittently operated extruder of more or less conventional design placed against the sprue of a mold which is held closed by a toggle mechanism or hydraulic clamp. If it is necessary to operate the extruder after the mold cavities are filled, an arrangement may be provided for receiving the excess material and returning it automatically either in bulk or reground to the extruder feed hopper.

There also is being developed a self-sealing or "droolproof" nozzle which closes automatically after injection to prevent dripping of the material between shots from the nozzle, or freezing of a cold slug in the nozzle tip. Naturally a much larger nozzle may be used with this type of protection against seepage and heat loss. Such a development might well necessitate considerable redesign and simplification of present sprue, runner, and gate construction to take full advantage of the increased molding speed and greater homogeneity of molding at lower temperatures which result from using large nozzles.

New adaptations of the jet molding principle

Many experiments are being carried on to perfect improvements or variations in the jet molding principle. This principle involves the forcing of a partially softened stream of material by high pressure against, through or past some type of comparatively highly heated surface. As the plastic comes in contact with the superheated surface and softens, the material gathers momentum, and receiving all the heat load necessary for the molding process (physical or chemical plastification or polymerization), passes rapidly into the cavity where it is allowed to harden or cure. In order that the process may be continuous, the temperature of the superheated passage is reduced when the material flow stops, the process of adding heat halted, and material held at an intermediate temperature pending the next cycle.

The fact that many plastic materials may be submitted briefly to a higher temperature than they could normally stand if exposed for any length of time, surely will affect the design of many future injection machines. This principle of brief exposure to a superheat is obviously already incorporated in jet molding.

Undoubtedly the capacity of jet molding units will be materially increased by lengthening the present jet, or increasing the area of the surface to which the plastic is exposed to allow more material to be quickly heated. High frequency current might be used to penetrate the entire section of a large stream of material, or the single jet may be replaced by some other type of surface—say a slot or plate placed in the material stream to impart heat to the material and cause it to move rapidly into the mold cavity. A three-part mold might be used, for example, eliminating the nozzle. The material would be forced through a slot contained in the stationary half of the die which is split, so as to allow the slot to be scavengered after each shot if desired. As the material passes through the stationary half of the mold, enough heat could be added to cause it to reach molding temperature by the time it got to the cavity proper. At any rate, the principle of jet molding will almost surely appear in many guises in future machines, and many future high speed molding jobs will use it.

Proposed design for automatic transfer molding

Still another type of machine might be mentioned as offering possibilities for improving the injection of thermosetting materials in particular. Such a machine would consist of a series of preheating chambers mounted on a rotary device. As the material in a given chamber reaches the molding temperature, the rotary revolves and presents the prepared charge to a plunger which forces the material into the mold. After the plunger withdraws, any residual material is automatically discharged from the preheating chamber as the unit revolves. A new charge is added, and heat applied until the preheating chamber again presents itself to the plunger. Such a device probably would be regarded in the trade as a fully automatic and continuous transfer molding machine and would undoubtedly find many applications.

New safety features

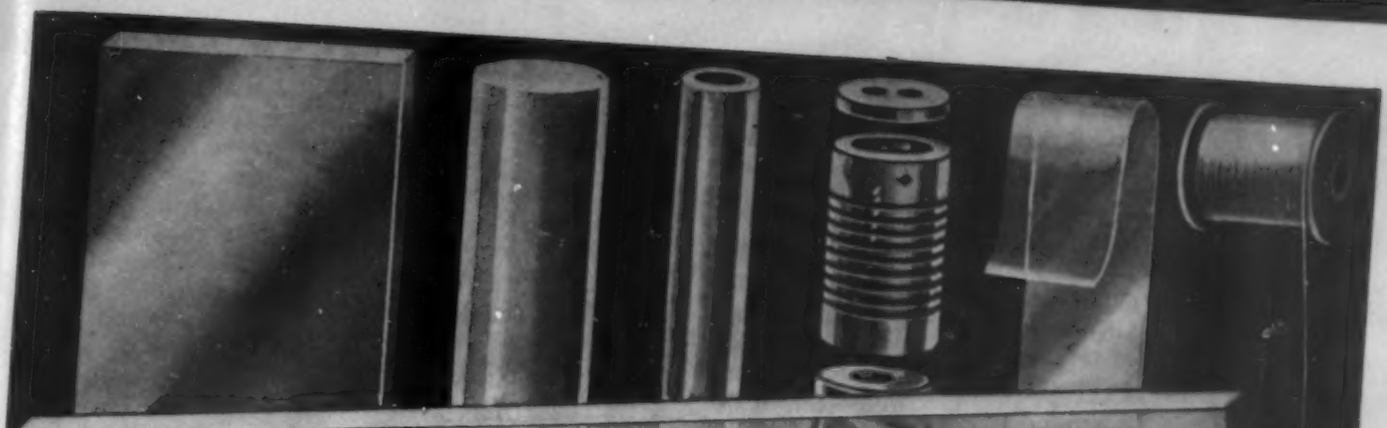
There will be many novel safety features found on new injection machines. The electric eye will most likely replace the present awkward safety gates and other purely mechanical devices. One machine already has been suggested which automatically reopens if a piece of flash or any other type of obstruction, even a piece of paper, becomes inserted between the dies. Such devices will protect not only personnel but molds and molded parts.

Conclusion

It may be clearly seen that the future of injection molding in this country is full of many promises of new and better things. As quickly as plastic materials are perfected for new uses, methods will be advanced for molding them in large volume. Who can say that the current Government war-essential restrictions on plastics in the United States may not result in a new era for plastics, especially if the many projects and developments now being considered are given materials enough to allow them to be developed into concrete realities? Let us hope that the energetic spirit of invention will continue to survive the soporific effects of regimentation and central controls, and in so persisting be able to produce the many plastic items which the peaceful world will demand.

The following list covers some of the U. S. patents which contain ideas that could conceivably affect the design of future injection molding machines.

133,229	Hyatt	1,916,495	L. E. Shaw
222,229	Beals	1,919,534	L. E. Shaw
461,722	Thurfelder	1,936,285	Bond
791,649	Richards	1,972,166	Schneider
937,477	Shonberg	1,977,515	Klippel
1,041,113	Lindsay	1,993,942	Novotny
1,226,408	Tenca	1,997,074	Novotny
1,397,358	Bronander	2,017,216	Marcus
1,470,755	Lane	2,026,098	Lester
1,482,263	Said	2,033,735	Pack
1,510,779	Herrmann	2,043,584	Husted
1,533,617	Soss and Martin	2,057,945	Gastrow
1,568,955	Buchholz	2,090,489	Sommerfield
1,596,150	Bungay	2,111,857	Jeffry
1,674,387	Campbell	2,112,342	Lester
1,724,331	Will	2,115,590	Ryder
1,735,668	Benge	2,160,108	Reid
1,768,671	Devine	2,192,263	Johnson
1,809,983	Lodge	2,199,144	Tegarty
1,810,023	Lodge	2,233,354	Thilenius
1,810,126	Buchholz	2,296,296	C. D. Shaw
1,899,053	Petersen	2,296,295	C. D. Shaw



NEW DATA ON IMPROVED PLAX POLYSTYRENE

Plax is one of the biggest producers of commercial polystyrene products in this country — and, so far as we know, uses more polystyrene for experimental purposes than any other company.

Out of this experience Plax presents these new data, suggesting how much better Plax Polystyrene can meet your own high-frequency insulation problems.

Compare its electrical characteristics with those of high-grade mica and fused quartz, add features unusual in any plastic, and you'll agree with other leaders in your field that Plax Polystyrene is one of the best high-frequency insulations ever known.

In addition to offering polystyrene sheets, rods and tubes themselves, Plax machines them into a wide variety of standard and special electronic parts.

From polystyrene, Plax now makes Polyflex Sheet. Tough and flexible, it is easily punched and has obvious uses for condensers, cable, storage batteries, etc.

Also new is Polyflex Fiber, proved in production and in the field as a cable wrapping and in other high-frequency applications.

Ask Plax for more data on these products, for engineering help in applying polystyrene to your products, and for a bulletin on machining polystyrene. In other words, "When it comes to polystyrene, come to Plax."

PROPERTIES OF PLAX POLYSTYRENE

MECHANICAL

Tensile strength, lbs. per sq. in. (A.S.T.M. D 48-37) 5,500-7,000

Tensile proportional limit, lbs. per sq. in. (.01% offset)

−38 F = 3,700
0 F = 2,800
78 F = 2,500

Modulus of Elasticity in tension, lbs. per sq. in.

−38 F = 554,000
0 F = 536,000
78 F = 469,000

Compressive proportional limit, lbs. per sq. in. (.01% offset) 2,600

ELECTRICAL

Volume resistivity, ohm. cm. 10^{17}

Arc resistance (A.S.T.M. D 495-38T) sec. 240-250

Dielectric strength, volts per mil

.005" thickness = 3,500
.010" thickness = 2,500
.015" thickness = 2,200
.125" thickness = 500-700

Frequency Cycles	Dielectric Constant	Power Factor
60	2.5-2.6	.0001-.0002
10^3	2.5-2.6	.0001-.0002
10^6	2.5-2.6	.0001-.0004
10^{10}	2.5-2.6	.0002-.0004

THERMAL

Distortion temperature (A.S.T.M. D48-37), F (C) 176-194 (80-90)

Transition temp. F (C) 180 (82)

Softening point, F (C) 220-240 (104-116)

Ignition point, F (C) 1650 (732)

Specific heat, cal. per gr. per degree C. .32

Thermal expansion coefficient per degree C 7.3×10^{-5}

Thermal conductivity — cal. per sec. per cm. per degree C 3.2×10^{-4}

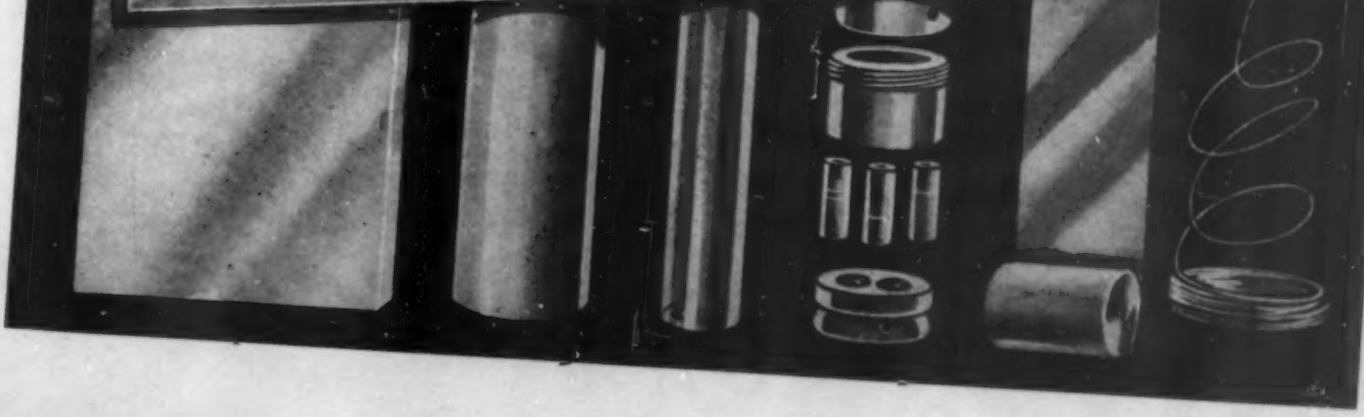
CHEMICAL

Effect of:

*Weak and strong acids	none
Weak and strong alkalis	none
Alcohols	none
Esters	soluble
Ketones	swells
Aromatic and chlorinated hydrocarbons	soluble

*Except oxidisers which discolor.

PLAX CORPORATION 133 WALNUT ST. HARTFORD, CONN.



Low-pressure molding

(*Continued from page 60*) degree of "undercure" may be determined by the acetone extraction of the laminate or by its solubility or swelling in aromatic hydrocarbon solvents, depending upon the type of resins employed.

The molded-laminated sheets just described can be heated to softening temperatures by some convenient method, such as subjecting them to heated vapor, immersing them in a hot liquid, or placing them between heated platens. They can then be formed in wood, plaster or cast molds, or they may be rolled on mandrels. Angles, simple curves, and rolled edges are formed with a varying degree of ease, depending on the thickness and temperature of the laminated sheet.

Abrasion resistance, water resistance and improved finish may be imparted to plywood panels by a surface layer of resin-treated paper or fabric which may be either molded directly to the plywood core or molded separately and then glued by the hot- or cold-press method to the wood. Normal wood bonding pressures are effective in producing the above composite structure.

Among the interesting molded-laminated parts that are being produced are:

Molded wing tips	Funnels
Pilot seats	Terminal boxes
Flooring	Photographic equipment
Ailerons	Data cases
Wing tabs	Fairings
Tail cones	Doors
Ammunition chutes	Air ducts
Wing and fuselage sections	Instrument cases
Air deflectors	Jettison gas tanks for aircraft
Inspection covers	Small boats for the Navy

With this impressive list of today's essential wartime products, designers, laminators and molders are entitled to dream of low-pressure laminated-molded products of the future. A small Navy boat, for example, is not far removed from a portable dinghy, or a lightweight bathtub. Aircraft air ducts bring to mind non-corrosive air-conditioning and ventilating ducts. Pilot seats indicate molded plow seats and school seats may become a reality. Since size of moldings can be much larger, there may be refrigerator cabinets, kitchen cabinets and lockers produced by low-pressure laminating-molding.

***14**—A test piece 8 in. in diameter and 3/4 in. deep, illustrating depth and vertical side walls made possible by drawing.* ***15**—This tray was produced by low-pressure molding—laminating from resin-treated cotton fabric*

14

15

Technical committees

(*Continued from page 106*) non-competitive nature, to establish standard airplane parts, specifications, design methods and fabrication practices, and to submit recommendations to the interested Government agencies when deemed advisable or at the request of such agencies. NASC standardization projects also include aircraft systems and installation problems. The following subcommittees have been organized to handle this work: Power Plant, Hydraulics, Controls, Supercharging, Armament, Furnishings, Heating and Ventilating, Landing Gear, and Electrical, Radio and Instruments. The company members of the National Aircraft Standards Committee are as follows:

Beech Aircraft Corp.
Bell Aircraft Corp.
Boeing Aircraft Corp.
Brewster Aeronautical Corp.
Cessna Aircraft Co.
Chance Vought Div. of United Aircraft Corp.
Consolidated Vultee Aircraft Corp.
Curtiss-Wright Corp.
Douglas Aircraft Co., Inc.
Eastern Aircraft
Fairchild Engine and Airplane Corp.
Fleetwings, Inc.
Goodyear Aircraft Corp.
Grumman Aircraft Engineering Corp.
Harlow
Hughes Aircraft
Interstate Aircraft and Engineering Corp.
Kellett Autogiro Corp.
Lockheed Aircraft Corp.
Glenn L. Martin Co.
McDonnell Aircraft Corp.
North American Aviation, Inc.
Northrop Aircraft, Inc.
Republic Aviation Corp.
Ryan Aeronautical Co.
Vega Aircraft Corp.

The National Aircraft Standards Committee has initiated projects concerning plastic parts for aircraft and has published 8 National Aircraft Standards for Plastic Knobs which have been designated as NAS 120 to NAS 126 and NAS 168. The Committee has also prepared standards for plastic tubing and fittings and these will be available in printed form in the near future.

Government Technical Committees

ANC Technical Subcommittee on Plastics

The Army-Navy-Civil Committee on Aircraft Design Criteria is an organization composed of representatives of the aeronautical branches of the War, Navy, and Commerce Departments, whose function it is to establish design requirements for aircraft construction and to make such information available to the industry in the form of manuals and handbooks. A number of subcommittees have been appointed for the prosecution of this work. One of these is the ANC Technical Subcommittee on Plastics, the membership of which is as follows:

Army:
Major F. B. Fuller, Army Air Forces
Capt. R. M. Houghton, Army Air Forces
Capt. J. P. Vidosic, Army Air Forces
Lt. D. L. Grimes, Army Air Forces

Navy:
Lt. R. K. West, Bureau of Aeronautics (*Please turn to next page*)

SAVE HOURS OF TRAINING for your Screw Driving Army

PHILLIPS SCREWS ARE FOOL-PROOF!

Light-fingered and feminine . . . heavy-handed and he-man . . . raw recruit or veteran. All can be put on a high-production level on your assembly line by giving them Phillips Recessed Head Screws.

The scientifically designed Phillips Recess automatically centers the driving force and eliminates all driving troubles . . . fumbling, wobbly starts . . . slant-driven screws . . . burred and broken screw heads . . . and dangerous screw driver skids.

Screw and driver "become one unit", making such efficient use of turning power that driving is much easier and faster, regardless of driving method. And, power driving is made practical in most cases.

They cost less to use! Compare the cost of driving Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs less to have the advantages of the Phillips Recess!

KEY TO FASTENING SPEED AND SAFETY

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Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

Lt. R. Temple, Bureau of Aeronautics
H. R. Gordon, Naval Aircraft Factory
Henry Sang, Naval Aircraft Factory, *Chairman*

Civil Aeronautics Authority:
B. L. Springer, *Secretary*

National Bureau of Standards:
G. M. Kline

Forest Products Laboratory:
H. K. Burr (*Advisory Member*)
E. C. O. Erickson (*Alternate*)

This Subcommittee, under its official directive, is authorized to conduct the following work: prepare a Plastics Supplement to ANC-5; coordinate their work with research work on plastics at the Forest Products Laboratory; submit to the Working Committee of the Aeronautical Board proposed Army-Navy specifications for plastic materials and for methods of testing and inspection with particular reference to new materials and new types of tests. Material progress has been made on this program. The ANC Bulletin on "Plastics for Aircraft" has been sent to the printer. Four technical papers were presented by members of the Subcommittee at an ANC-Industry Conference held in February 1943. These have appeared in consecutive issues of this magazine in the Technical Section beginning in June. Drafts of specifications prepared by the Subcommittee covering plastics for aircraft structural uses are currently being reviewed by Government and industry groups prior to submission to the Aeronautical Board for their consideration for issuance as Army-Navy Aeronautical Specifications.

Federal Specifications Technical Committee on Plastics

The Technical Committee on Organic Plastics of the Federal Specifications Executive Committee is charged with the preparation of specifications pertaining to plastic materials and articles when the particular commodity is used by two or more Government departments or establishments in sufficient quantity to justify the preparation of a specification. Products of primary interest for military purposes to the Army and Navy are generally covered by specifications issued by the War and Navy Departments. The Federal Specifications Technical Committee on Plastics is made up of representatives of sixteen Government agencies as follows:

Agriculture:
C. E. Senseman, Bureau of Agricultural and Industrial Chemistry

Commerce:
G. M. Kline, National Bureau of Standards, *Chairman*
A. L. Morse, Civil Aeronautics Administration

District of Columbia:
J. J. Crane, Public Schools
H. F. Clemmer, Materials Engineer
H. C. Slack, Penal Institutions

Federal Works Agency:
D. A. Howes, Housing Authority
H. H. Waples, Public Buildings Administration
O. E. Burton, Public Buildings Administration

Government Printing Office:
W. B. Spencer

Interior:
E. A. Poynton, Indian Service

Justice:
R. C. Dunbar, Bureau of Prisons
R. Hofstetter, Federal Prison Industries

Maritime Commission:
E. L. Sinclair
P. C. Pearson
F. Hazelwood

National Archives:
A. E. Kimberly

National Museum:
W. R. Duncan

Navy:
R. K. West, Lt., Bureau of Aeronautics
P. T. Rees, Bureau of Medicine and Surgery
R. O. Phillips, Lt. Comdr., Bureau of Ordnance
E. C. Forsyth, Comdr., Bureau of Ships
T. A. Werkenthin, Bureau of Ships
N. E. Ruckman, Bureau of Ships
R. J. Potbury, Bureau of Yards and Docks
W. A. Richards, Bureau of Yards and Docks

Tariff Commission:
J. H. Hibben
W. D. Buzzard

Treasury:
B. Siegel, Federal Specifications Div.
F. Brehme, Federal Specifications Div.

Veterans Administration:
W. R. Von Blom

War:
H. M. Cronk, Major, Army Air Forces
J. B. Johnson, Army Air Forces
E. H. Schwartz, Army Air Forces
M. H. Bigelow, Capt., Chemical Warfare Service
R. W. Peakes, Chemical Warfare Service
J. R. Richardson, Capt., Corps of Engineers
E. B. Bailey, Corps of Engineers
E. T. McBride, Major, Ordnance Dept., *Vice-Chairman*
G. Reinsmith, Ordnance Dept.
E. L. Hobson, Major, Quartermaster Corps
R. Wilson, Quartermaster Corps
J. B. Wonsetler, Standards Agency, Signal Corps

War Production Board:
C. L. Warwick, Conservation Division
Dean Harvey, Conservation Division
J. H. Savage, Conservation Division

Proposed Federal Specifications, and revisions of existing Federal Specifications, unless the changes in the latter are of a minor nature, are submitted to representative manufacturers, preferably through any central organization of the industry concerned, for comment or criticism and such recommended changes in the specifications as they may consider to be desirable. When these have been considered by the Technical Committee, the specification is submitted to the Executive Committee for circulation to the departments for official comment. When the departmental comments have been considered by the Technical Committee, the final draft of the specification is submitted to the Executive Committee for approval and promulgation by the Director of Procurement.

NACA Subcommittee on Miscellaneous Materials and Accessories

The National Advisory Committee for Aeronautics is authorized by Congress to supervise, direct and conduct scientific research on the fundamental problems of flight. The Subcommittee on Miscellaneous Materials and Accessories is charged with the responsibility of planning research on plastics, plywood and various miscellaneous materials, and of coordinating research in this field with investigations conducted by other research organizations. Some research on the development of plastics and plywood has been conducted in NACA laboratories. The Committee has in the past few years located most investigations of this type in the Organic Plastics Section of the National Bureau of Standards and in the laboratories of universities and scientific institutions. The Subcommittee on Miscellaneous Materials and Accessories has kept in close touch with the program on wood and plywood for aircraft applications currently under way at the Forest Products Laboratory.

The membership of the NACA Subcommittee on Miscellaneous Materials and Accessories is as follows:

W. E. Emley, National Bureau of Standards, *Chairman*
C. J. Cleary, Matériel Command, Army Air Forces
H. A. Gardner, Henry A. Gardner Laboratory
C. H. Helms, National Advisory Committee for Aeronautics
E. F. Hickson, National Bureau of Standards
G. W. Lewis, National Advisory Committee for Aeronautics
G. M. Kline, National Bureau of Standards
A. L. Morse, Civil Aeronautics Administration
C. R. Johnson, Lt. Comdr., Bureau of Aeronautics
G. W. Trayer, U. S. Forest Service, Dept. of Agriculture

War Committee on Radio

The Radio and Radar Branch of the War Production Board contracted late in 1942 with the American Standards Association for the organization of a War Committee on Radio for the development of specifications for components of military radio. This Committee is composed of Subcommittees and Drafting Groups which handle the various materials and parts which enter into radio manufacture. Plastics are considered by Drafting Group 7 on Specifications for Plastic Radio Insulating Materials

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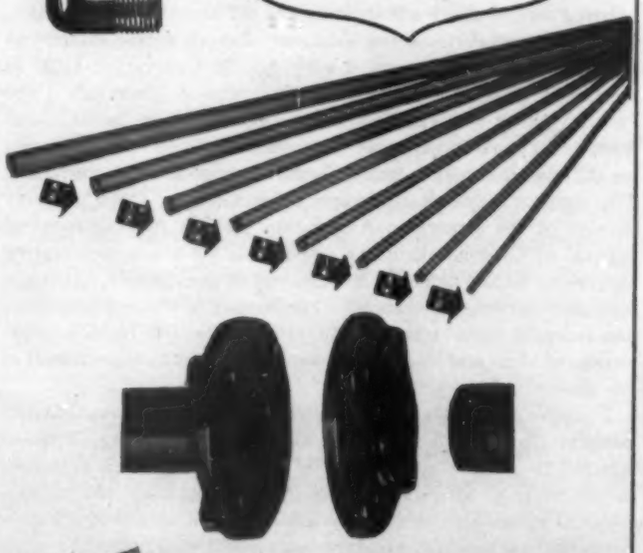

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CHICAGO: Steel Mill Products Co. • DETROIT: June & Company

of Subcommittee 1 on Insulating Material Specifications. The membership of this drafting group is as follows:

N. J. Rakas, Chrysler Corp., *Chairman*
A. Allan Bates, Westinghouse Laboratories
R. W. Auxier, Westinghouse Electric & Mfg. Co., *alternate*
Officer in Charge, Fort Monmouth Signal Laboratory
Robert Burns, Bell Telephone Laboratories
L. W. A. Meyer, Tennessee Eastman Corp., *alternate*
Officer in Charge, Standards and Tests Sect., Design Div., Navy Dept., Bureau of Ships, Washington, D. C.
M. P. Davis, Otis Elevator Co.
W. A. Zinzow, Bakelite Corp., *alternate*
Millard Demarest, Celanese Corp. of America
W. A. Evans, Bell Telephone Laboratories
W. Orvis, Bell Telephone Laboratories, *alternate*
W. E. Gloor, Hercules Powder Co.
Wyman Goss, General Electric Co., Plastics Dept.
Officer in Charge, Signal Corps Standards Agency, Red Bank, N. J.
G. M. Kline, National Bureau of Standards
Frank Reinhart, National Bureau of Standards, *alternate*
G. H. Mains, National Vulcanized Fibre Co.
Fred L. Stiegler, National Vulcanized Fibre Co., *alternate*
Garson Meyer, Eastman Kodak Co.
H. K. Nason, Monsanto Chemical Co.
A. F. Shepard, Durez Plastics and Chemicals, Inc.
E. B. Woodman, Durez Plastics and Chemicals, Inc., *alternate*
C. R. Stock, American Cyanamid Co.
George M. Kuettel, E. I. du Pont de Nemours & Co., Inc.
E. B. Cooper, E. I. du Pont de Nemours & Co., Inc., *alternate*
W. G. Goggin, Dow Chemical Co.
R. W. Barber, St. Regis Paper Co.
N. R. Yorke, St. Regis Paper Co., *alternate*

Drafting Group 7 has organized three subgroups to review specifications which were prepared by the Signal Corps. These are Subgroup A on Thermosetting Molded Plastic Materials under the chairmanship of W. A. Zinzow, Bakelite Corp., Subgroup B on Thermoplastic Materials under the chairmanship of H. K. Nason and Subgroup C on Laminated Plastic Materials under the chairmanship of G. H. Mains.

Technical Societies

ASME Rubber and Plastics Group

The American Society of Mechanical Engineers is composed of 17 Divisions and Groups made up of individuals interested in particular branches of engineering. The Society's objectives are the promotion of interchange of information on engineering subjects, sponsorship of research in this field, and cooperation with other engineering societies and Government agencies on engineering projects. The Rubber and Plastics Group is the most recently organized branch of the Society. The Executive Committee for 1943 is as follows:

G. M. Kline, National Bureau of Standards, *Chairman*
E. F. Reising, Firestone Tire and Rubber Co., *Vice-Chairman*
R. A. Boyer, *Secretary*
L. E. Jermy, Machine Design
J. F. Downie Smith, United Shoe Machinery Corp.
E. G. Kimmich, Goodyear Tire and Rubber Co.
F. L. Yerzley, Western Electric Manufacturing Co.

The Rubber and Plastics Group have held two meetings annually during the past 4 years and have sponsored papers giving information on current engineering practices, progress reports on research and development and complete records of engineering work of permanent value. These papers have been published in the Society's publications, Mechanical Engineering and the A.S.M.E. Transactions, and in trade publications in the rubber and plastics fields. Many of them have related to developments in aircraft applications of these materials. The most recent meeting of the Group was a joint session with the Aviation Division in Los Angeles in June, at which four papers pertaining to the properties and aircraft applications of plastics were presented. These papers will appear in the Society's publications and in early issues of this magazine.

ASTM Committee D-20 on Plastics

The objectives of the American Society for Testing Materials are the promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing. Investigations on materials are conducted by the committees and individual members of the Society and by joint researches with other organizations. The results are presented as reports and technical papers at Society meetings and subsequently published. The development of standards is carried out by the some 60 standing committees, each of which functions in a prescribed field and under definite regulations to insure adequate representation of producers, consumers and general interests.

Committee D-20 on Plastics has approximately 100 voting members, divided about equally into producer, consumer and general interest groups. The scope of the committee's work is defined as the development of test methods and specificatons applicable to the finished products (molding materials, sheets, tubes and rods, and molded or fabricated articles) in the field of plastics. The scope does not include electrical tests and materials used in the paint and rubber industries, which are covered by other committees. The officers and chairmen of the subcommittees of ASTM Committee D-20 on Plastics are as follows:

Robert Burns, Bell Telephone Laboratories, Inc., *Chairman*
H. K. Nason, Monsanto Chemical Co., First Vice-Chairman
W. E. Gloor, Hercules Powder Co., Second Vice-Chairman
L. W. A. Meyer, Tennessee Eastman Corp., Secretary
M. H. Bigelow, Chemical Warfare Service, Chairman, Subcommittee I on Strength Properties
L. Boor, American Cyanamid Co., Chairman, Subcommittee II on Hardness Properties
W. A. Zinzow, Bakelite Corp., Chairman, Subcommittee III on Thermal Properties
W. F. Bartoe, Rohm and Haas Co., Chairman, Subcommittee IV on Optical Properties
J. H. Teeple, Celanese Corp. of America, Chairman, Subcommittee V on Permanence Properties
G. M. Kline, National Bureau of Standards, Chairman, Subcommittee VI on Specifications
P. D. Brossman, E. I. du Pont de Nemours and Co., Inc., Subcommittee VII on Analytical Methods
H. K. Nason, Monsanto Chemical Co., Chairman, Subcommittee VIII on Research

Another subcommittee has recently been organized to work on standardization of the preparation of test specimens in cooperation with the Society of the Plastics Industry. This is Subcommittee IX on Molds and Molding Procedures.

Other Technical Societies

There are several other technical societies whose individual activities and cooperative efforts with other groups have contributed materially to advancement of our knowledge of plastics. The Society of Automotive Engineers has an active interest in this field and has cooperated with ASTM Committee D-20 in the preparation of specifications for plastic materials. The Paint, Varnish and Plastics Division of the American Chemical Society has been the source of many valuable papers and symposia on the chemistry and chemical engineering of these materials. The summer research conferences sponsored by the Chemistry Section of the American Association for the Advancement of Science at Gibson Island are responsible for many stimulating excursions to and beyond the frontiers of published information on high polymeric substances. The Society of Plastics Engineers has recently been organized to provide for the further interchange of ideas and information among the technical personnel of the plastics industry.

The efforts that have been made within the aircraft and plastics industries to provide central committees for handling problems relating to aircraft applications of plastics have been described in this report. A similar coordination of work by the various Government groups active in this field is imminent. It is highly desirable that a similar program be followed with respect to other phases of technical activity in plastics in order to avoid needless duplication of effort. It is particularly pertinent for Government agencies, trade groups and technical societies to consider cooperating with established and active committees in finding the solutions to new problems rather than setting up independent committees for this purpose. This approach to such problems is especially advocated by the technical personnel of the industry who find their time and energy taxed by multiple memberships on technical committees.

We're Both on the Spot . . . Brother!

IT'S all one battle—the roaring dive of a squadron on the target and the precise thoroughness of laboratory and precision manufacturing facilities brought to bear on today's one big objective—MORE PRODUCTION!

The battle begins here—that puts us both on the spot! *Your problem* is to get even the toughest plastic jobs done ahead of schedule. *Our problem* is to supply the *quality-controlled* materials and methods to meet the production finishing demands of those jobs.

So, let's fight and work together. Today, as always, we are interested in helping you solve your plastic finishing problems. If you are a manufacturer extending the ways in which Plastics are serving our armed forces, you may have need of the broad, practical plastic finishing knowledge presented by McAleer's **Plastics Finishing Division.**

Here, a laboratory research staff with facilities second to none works closer than ever with McAleer engineers in the field, developing new materials, new methods daily, any one of which may be just the solution to your toughest plastic finishing problem.

So, step off the spot. If yours is a plastic whose base material is among those listed below, there is a "tailored-to-the-job" McAleer composition or product that is best suited to your particular finishing needs. Learn for yourself what such a product plus McAleer on-the-job Advisory Service can mean to you in terms of better plastic finish, increased production, at less cost. At no obligation, of course.

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MOLDED CONTROL PULLEYS

By molding these pulleys complete with ball-bearings, we eliminated the need for metal bushings. This method avoids variations that may occur when bearings must be fitted to bushings; saves time formerly required for assembly. Other benefits obtained through plastics functional design:

Mold-finish of groove is smoother and harder than machined surfaces; this serves to prolong cable life.

Strength is in excess of Army and Navy specifications, according to tests.

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Our pulleys are precision-molded from a phenolic compound reinforced by macerated fabric to afford greater durability.

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DU PONT FORMALDEHYDE . . . full strength U.S.P. solution, water-white in color, low in acid and low in metal content.

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Tubing and tube fittings

(*Continued from page 67*) tion as to who may produce, purchase, sell or use parts made in accordance with these standards.

These standards will be adaptable for many commercial items whose low cost and ease of procurement will make them desirable for such units as household refrigerators, washing machines, automobiles, and others now in development or not yet conceived. The plumber and the amateur mechanic will also find many uses for them. Testing and development laboratories will find these items desirable because of their ease of assembly and disassembly, transparency (for observation of flow), and low economic loss through destruction tests. In applications where the temperatures are not so critical as in aircraft, but where chemical resistance is more so, other tubing materials, such as polyvinylidene chloride resin, may be used.

The consensus is that this series of standards is a very important development. Its early creation should serve to guide the design of tooling so that parts from different sources of manufacture are interchangeable, and should simplify many present and future problems by making readily fabricated non-metallic parts available.

Washington round-up

(*Continued from page 120*) instead of a fee of $50 for a single patent plus $5 for each related patent included in the same license.

Information concerning the 40,000 patents and patent applications now held by the Alien Property Custodian can be obtained by addressing the Office of Alien Property Custodian, Field Building, Chicago, Ill. Except for those patents which already were exclusively licensed to American industry prior to seizure, patents which formerly belonged to enemy nationals are now available under license on a non-exclusive, royalty-free basis for the life of the patents. No patents or patent applications are offered for sale.

SAMUEL S. ULLMAN JOINS OPA

Samuel S. Ullman, of Northeastern Molding, Inc., and Northeastern Plastics Corp., has joined OPA as a plastics specialist in the Machinery Branch. Before joining OPA he had served as controller and general manager of the two companies named. He has been in the plastics industry since 1936.

SUMMER EDITION OF GOVERNMENT MANUAL

The Summer edition of the United States Government Manual, a 707-page reference book on the creation and organization, functions and activities of the Federal Departments and Agencies, containing changes through May 15, is now available. It may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., or at the U. S. Information Center, 1400 Pennsylvania Avenue, N. W. Single copies cost $1; subscription covering three editions, $2.75.

COTTON LINTERS ARE ESSENTIAL

Cotton linters are among the little-known raw materials used in the manufacture of both civilian and military goods that are placing increasing strains upon the supply picture. A round-up of wartime uses reveals their vital importance to war production, including production of the plastics industry. Plastics, no longer considered as substitutes, are more and more important as war materials. Essential civilian uses of plastics include surgical goods, wire insulation, toothbrushes and drug closures. Even the Army is not permitted to use plastics for non-essentials, but is limited to such fundamentals as plane windows and noses, cockpit enclosures, gun turrets, control knobs, instrument panels and helmet linings.

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You should—ask any plastics engineer. CLAREMONT cotton flocks make better moldings because they are ***longer*** (therefore giving better impact and tensile strengths) ***cleaner*** (giving full play to the natural strength and purity of the resin, insuring accurate color) and more ***uniform*** (making for better molding qualities and freedom from imperfections in finished work).

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ARE AVAILABLE *Now*
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Our preoccupation for the duration with vital war work, precludes acceptance of non-critical molding problems. BUT our expert staff of plastic engineers, advisors and production men (who *really* know plastics) ... can help you plan for a "fast start" when plastic materials are again available for civilian use.

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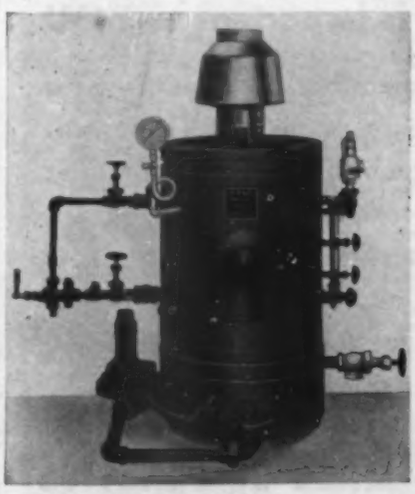

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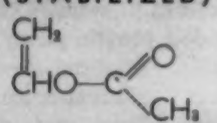

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OUR 23 years in the Molding of Plastics is important to YOU

It is important because it means when this war is won we will have an invaluable fund of experience to put at your disposal, unhampered by priorities or other restrictions. Right now we welcome the opportunity to help you produce the vital parts that will *help to win* this war.

CAN IT BE MADE OF PLASTICS? ASK

Kuhn & Jacob

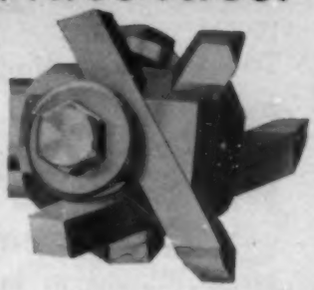
MOLDING and TOOL CO.

1204 Southard St., Trenton 8, N. J.

New York Office, PEnn 6-0346

a totally different kind of surface facer

IMPOSSIBLE? You bet not! Every claim made for this tool can be proved!



1 Replaces End, Shell, Slab Mills, and Inserted Tooth Cutters;
2 Fits all vertical and horizontal milling machines, drill presses and other spindle machines;
3 Quickly and accurately adjustable, just four tool sizes cover all fractional diameters from 1¼" to 5";
4 Slashes tool costs up to 75%;
5 Clark tool blades are not ruined by hard spots in castings, re-extruded Dural, etc.—bits may be quickly touched up and sharpened free hand;
6 Tool blade life is unusually long, replacement cost low;
7 Cuts any material under the most severe operating conditions accurately, swiftly, economically;
8 Ample blade clearance avoids chip clogging and resultant slowdowns;
9 Tools available with all types of blades, including carbide tips;
10 Prompt delivery on suitable priority.

CALL YOUR JOBBER TODAY
WRITE FOR BULLETIN NO. MP-8

CLARK ADJUSTABLE
FACING TOOL

GET THE FACTS about Clark Adjustable Hole & Fly Cutters —they, too, are remarkable new-type tools!

Canadian Distributor: DOMINION BEARINGS, LTD. • Toronto • Montreal • Winnepeg

Robert H. Clark Company
3424 SUNSET BLVD. • LOS ANGELES 26
MANUFACTURERS: PRECISION TOOLS, PRECISION PARTS

NO SHOCK at 6000 psi.

It is not at all uncommon to see reducing valves that cause shock even at comparatively low pressures. Yet here is the

ATLAS Type "E"
High Pressure Reducing Valve

which handles pressures as high as 6000 lb. per sq. in. with the utmost ease—WITHOUT SHOCK. It handles water, oil, or air, and although it is widely used in plastics plants we find that some executives haven't heard of it as yet and that is why we are advertising it in MODERN PLASTICS. Be sure to get acquainted with it.

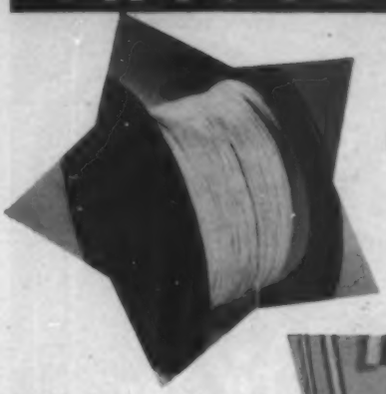
Why Does It Excel?

Give ATLAS Type "E" a thorough examination and you will find that it is modern in every respect. It is founded on the latest design and research. Forged Steel Body. Internal metal parts entirely of stainless steel. A formed packing of special material superior to leather is used which is immune to all fluids commonly used in hydraulic machinery. The pressure on the seat is balanced by a piston with the result that variations in high initial pressure have little effect on the reduced pressure.

For other ATLAS plastics plant products see the partial list in our ad in the January issue of MODERN PLASTICS.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
277 South Street, Newark, N. J.
Representatives in Principal Cities

ON EVERY FRONT!



PLASTIC PRODUCTS
ARE BEING WIDELY USED IN CONNECTION *with*
COMMUNICATIONS
RAILROADS
& AVIATION

SARAN—
- MONOFILAMENT
- TUBING & FITTINGS
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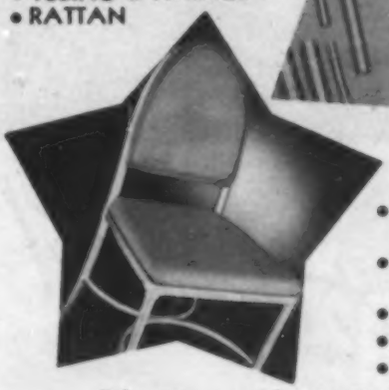

- NOT AFFECTED BY ACIDS & ALKALIES
- EXCELLENT DIELECTRIC QUALITIES
- LIGHT IN WEIGHT
- STRONG
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Plastics That Fit The Job

We Especially Invite

MOLD MARK

INQUIRIES FROM MANUFACTURERS OF TEXTILES, FILTERS, UPHOLSTERING MATERIAL, ETC.

EXTRUDERS
OF ALL TYPES OF
THERMOPLASTIC MATERIAL

NATIONAL PLASTIC PRODUCTS Company
ODENTON, MARYLAND

COTTON FABRICS

FOR REINFORCING

PLASTICS

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J. H. LANE & CO., Inc.

250 W. 57th St. · New York, N. Y.

To keep pace with the rapid expansion of our business and to enable us to give better service to our customers, we have moved into larger and more convenient quarters. We are now better equipped to take prompt care of your requirements in extrusion molded plastics, including tubing and all types of standard and special shapes. Write for Bulletin 300.

CARTER

PRODUCTS CORPORATION

Manufacturers of EXTRUDED PLASTICS

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DWPC

See that Helmet!

(THE LINER IS A PHENOLIC LAMINATE)

IT'S THE BEST IN THE WORLD

THE MATERIAL FROM WHICH THE LINER WAS MOLDED IS A PHENOLIC IMPREGNATED FABRIC PRODUCED IN OUR PLANT TO STRICT SPECIFICATIONS.

We have treated fabrics and papers with phenolic varnishes for the following laminating uses:

Helmet Liners, Filter Media for use in Tanks, Planes, Jeeps, Tank Destroyers, Ships, etc., Airplane Fairings (low pressure molding), Jeep and Ship Parts, Ship Bearings, Fire Extinguisher Nozzles, Instrument Covers and Cases, Instrument Panels.

All treatments were to customer specifications for a specific laminating use.

If you have a laminating problem requiring special material or material treated to specification, we invite your enquiry.

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PLASTICS DIVISION

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PLASTIC MOLDING

FOR THE TRADE

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INDUSTRIAL DIVISION

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DIFFICULT?

SURE, BUT NOT WHEN YOU KNOW HOW...

Perhaps today you have a plastic problem that seems difficult, maybe impossible to solve.

But is it really?

Nine chances out of ten there is a practical solution — a solution that can be found through the experience and skill of the C. F. Church Manufacturing Company.

Injection
Compression
Plastic Molding

CFC

C. F. CHURCH MFG. CO. · HOLYOKE, MASS.

Division of American Radiator & "Standard" Sanitary Corporation

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INDUSTRIAL FINE COTTON SHEETINGS

for

PLASTIC TRADES

Inquiries Solicited

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Owning and Operating Mills at

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MERCER-ROBINSON COMPANY INC.

Material Handling and Processing Equipment

30 CHURCH ST., NEW YORK

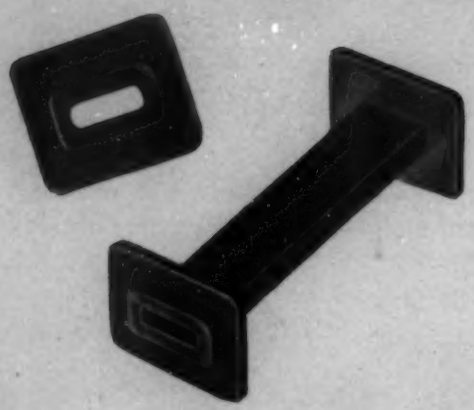
Sole Representatives of the Combined Engineering and Manufacturing Facilities

— of —

MERCER ENGINEERING WORKS, INC. Clifton, N. J.

ROBINSON MANUFACTURING CO. Muncy, Pa.

NO JOB TOO TOUGH



The piece shown looks simple. It isn't.

Three sets of dies are required to produce it. It is molded of two distinct types of phenolic material. The ends are molded of high-impact phenolic. They are then used as *inserts* and the core of high tensile strength material is molded in and around them.

This is a sample of the unusual problems in producing high-dielectric strength plastic moldings which our company licks every day for a number of important accounts.

We make our own dies, and have a group of our own plastic materials with special insulating qualities. We do both stock mold and custom work. Bring us your problem.

INSULATION MANUFACTURING CO.

CUSTOM MOLDERS OF PLASTICS FOR INDUSTRY

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STANDARD TOOL COMPANY

75 WATER STREET LEOMINSTER, MASS.

1911 — 1943

Thirty-two years experience in Plastics enables us to aid plastic manufacturers in serving their Government more efficiently.

Our experienced engineering department offers the latest and best design in the advancement and development of Plastics—Molds and Equipment.

Lester Injection Molding Machines—New England Representatives. The latest and largest—**4-ounce to 22-ounce.**

Conservation of vital materials calls for efficient **Scrap Grinders**—Ball & Jewell New England Representatives.

Plastic Material Dryer—Parks Standard—U. S. Agents. An efficient Dryer of all materials, scientifically developed for this purpose alone.

Gages—Jigs—Fixtures. Because of our highly skilled personnel and modern equipment, we are serving the Government in the manufacture of these precision tools.

Screws

Our catalog is no colorful picture book—but it is easy to use and easy to find things in. It was devised for the superintendent, the master mechanic and the purchasing agent. It is a catalog of standard and special screws—wood or metal—stripped right down to facts and specifications. If you haven't a copy, please send for it.

MACHINE SCREWS — PLASTIC INSETS
SHEET METAL SCREWS — HOLDING PINS
MACHINE SCREW NUTS — SPECIAL RIVETS
All types of heads and threads

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INCORPORATED 1892

Preheat your Thermosetting Plastic Preforms by Electronic

Intertherm* Reaction

Intertherm Reaction (RF Dialectric Heating) internally preheats plastic preforms . . . giving highest temperatures in the CENTER . . . insuring a uniform resin flow during compression and transfer. Intertherm can reduce press closing and curing time by two-thirds plus. Intertherm aids appearance by pre-eliminating excess volatiles . . . reduces rejects . . . permits larger mouldings on same press capacity.

Complete generator units ready for installation in your plant. Fast delivery on highest priorities.

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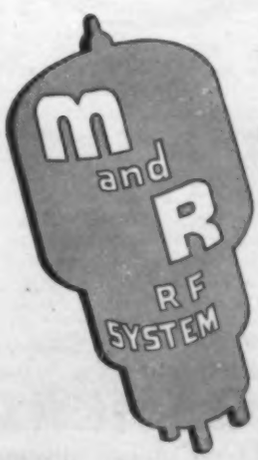

Northwest Syndicate Inc.

711 St. Helens Ave.
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For RELIABLE PLASTIC CHEMICALS

Formaldehyde

PARAFORMALDEHYDE
HEXAMETHYLENETETRAMINE

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PENTEK

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PENTACIZERS

A Series of
NEW AND INTERESTING
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PENTAWAXES

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CHICAGO BRANCH: 180 N. WACKER DR.

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for

Laminators and Molders

Our Southern mills have made high tensile cotton fabrics for the Plastics industry for fifteen years and specialty industrial cotton textiles for over thirty-five years. Our experienced development and production facilities are available to the Plastics trade, limited only by the requirements of our armed forces.

Curran & Barry

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MEET THE BOSS WHO HAS One Labor Problem Less

P.S. he owns an

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Here is a machine that multiplies Man-Power—releasing men, women *and equipment* for other work. Speeds up production! Saves valuable hours now spent on copying and tracing by making photo-exact copies at small expense—in your own place of business, without delays.

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APëCO makes copies up to 18"x22"—1 to 100 copies or more. No chance for error! Legally acceptable.

Foolproof Operation - Sturdy Construction
With our simple instructions, any inexperienced boy or girl can produce photo-exact copies of letters, blueprints, drawings, work orders, specifications, etc. No skill or darkroom needed.

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$55 F.O.B. CHICAGO

This Is the Time for Precision

Talk to a soldier who has just returned from a theatre of operations. He'll tell you that "the front" is no place to *test* accuracy. When the boys in the thick of it get something new to use, it has to be *right!*

The precision molds for plastics that we're making are accurate to within .00005 of absolute—the molded parts produced from them are likewise accurate. So, the precision of fit and action is *insured.*

More than merely to meet specifications and avoid rejects, your regard for the men in uniform should dictate your use of *precision* molds. We invite your inquiries.

ELECTRIX *Corporation*

Peace-time engineers of soft-rubber connectors for electrically-operated equipment

150 MIDDLE ST., PAWTUCKET, R. I.

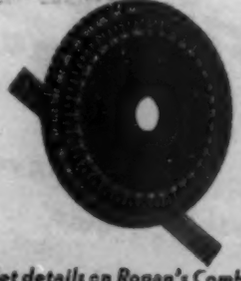
FOR MARKING *Plastics*

"THE SCALES TIP"

IN FAVOR OF

The "chug-chug" engraving method of marking plastic parts has seen its best days. Now, the swing is to Rogan's faster, exclusive method of BRANDING in *Deep Relief . . . officially approved* as the equal of engraving.

Countless big war contractors have found that Rogan *Deep Relief* Branding speeds up the production of vital plastic parts . . . cuts their costs and helps meet delivery schedules.



The famous Azimuth Navigation Dial shown at left, is a typical example of how Rogan can meet rigid specifications. And too, this is an *exclusive* Rogan Branding job.

Accurate graduations, lettering, designs or markings of any kind, can be branded into plastic parts of any material, of every size and shape . . . permanently.

Get details on Rogan's Combination Molding and Branding Service

ROGAN BROTHERS

2005 S. Michigan Ave. Chicago, Illinois

THE FINGER-TIP CONTROLLED

FOREDOM FLEXIBLE SHAFT MACHINES

Are As Versatile and Adaptable As Plastics Themselves

Model illustrated is Foredom No. 340. Comes with either foot or hand-operated rheostat at $45.70. (Available with suspension-type motor, No. 240, at $43.20, including foot rheostat.) Other models as low as $23.50.

The finger-tip controlled Foredom gets into many places ordinarily inaccessible and does many jobs quickly and efficiently that otherwise require expensive, time-consuming hand labor. The versatility of Foredom Flexible Shaft Machines is matched only by the versatility of plastics themselves. Foredom's wide-range of easily interchanged accessories and choice of four different handpieces, means that every Foredom Machine is ready at a moment's notice to rout, carve, trim, finish, mill, drill, slot, bore—or perform many other services in repairing and maintaining heavier equipment, touching up molds, or working on plastics themselves.

Finger-tip control . . . . . plus a wide variety of accessories . . . . . means precision workmanship, unlimited adaptability.

A copy of our new Catalog No. 414, showing our complete line of FOREDOM Flexible Shaft Machines and Accessories will be sent you on request.

Grinding, cleaning, finishing, polishing and correcting molds

Finishing and touching up plastic molded parts.

FOREDOM ELECTRIC CO. ESTABLISHED SINCE 1922 27 PARK PLACE, NEW YORK, N. Y.

Specialized STEARATES OF ZINC CALCIUM ALUMINUM

● As molding speeds climb steadily higher, it becomes more *essential* to provide better lubrication both for the molding material and for the mold itself. For the complete answer to both these problems, it will pay you to turn to Metasap. For, in addition to giving worry-free lubrication, Metasap Metallic Soaps supply a very desirable plasticizing effect. For further information write.

METASAP CHEMICAL COMPANY

PALMITATES
STEARATES
of ALUMINUM, CALCIUM, LEAD, ZINC

Harrison, N. J., Boston, Los Angeles, Chicago, Cedartown, Ga.

Our Job . . . Today
is to help WIN THIS WAR

100% Production for Our Armed Forces

We know we are doing our job — and doing it well. Every single Michigan Molded employee is giving the best he's got. Each knows that less than 100% effort is not enough.

However, our few relaxing moments are devoted to future markets and the many entirely new products we will be making in another all-out effort to help maintain the peace.

MICHIGAN MOLDED PLASTICS, INC.
Dexter, Michigan

CUSTOM M MOLDERS

100% PLANNING FOR FUTURE MARKETS

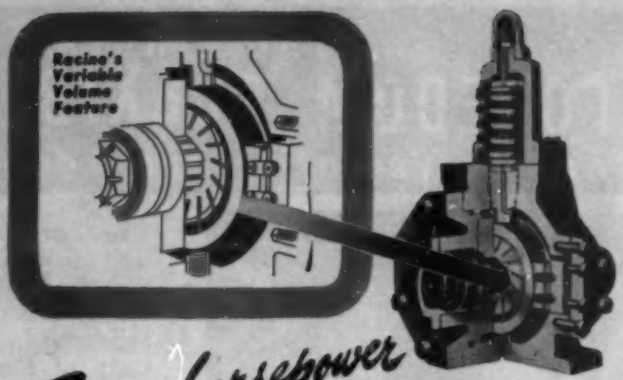
FILLERS

WOOD FLOUR
COTTON FLOCK
and FABRICS
OF SUPERIOR QUALITY
FOR THE

PLASTIC INDUSTRY

LARGEST DOMESTIC SUPPLIERS

BECKER, MOORE & CO., INC.
NORTH TONAWANDA, N. Y.



Save horsepower with RACINE

oil hydraulic — "variable volume" PUMPS

The "Variable Volume" design of Racine Pumps provides the most efficient use of power—for it pumps only the minimum amount of oil needed to do the job. No waste of power—no relief or by-pass valves required—reduces oil heating. Capacities are 0-12, 20 and 30 G.P.M. at 50 to 1000 lbs. pressure per sq. inch.

RACINE Oil Hydraulic FOUR-WAY VALVES

Racine's "Balanced Piston—Sleeve Type" construction assures complete hydraulic balancing and smooth oil cushioned operation. Complete line of valves for pressure and flow control. Sizes ⅜" to 1½".

Complete data and prices on Pumps and Valves on request. Address Dept. MPL-P.

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The Production Saws of Modern Industry. Available in a wide range of designs and prices. Capacities 6" x 6" to 20" x 20".

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RACINE TOOL AND MACHINE COMPANY
Standard for Quality and Precision

Complete Line of
Machinery for Celluloid and Plastics Mfrs.

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HARRISON Engineers and Machinists ESTABLISHED 1881 NEW JERSEY

Mixers: Plain or Stainless
Preliminary or Vacuum

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Canastota, N. Y.

TRADE DM MARK

A complete and thoroughly equipped molding plant with an enviable record of performance for many of the largest users of molded parts, products, premiums and packages

Call upon our engineers and designers for aid or advice in planning your molded parts.

DIEMOLDING CORPORATION
CANASTOTA NEW YORK

Of the innumerable problems incident to war production, an ever-increasing number are being solved with "Waterbury Plastics." Although this plant is operating on full schedules day and night, in order to keep that way, contracts must be renewed from time to time. So, if you are struggling with some difficulty — or can use an extra source of plastics supply — we will do our best to "give you a lift."

"Waterbury Plastics" service is *experienced* service . . . dating from the beginning of plastics in this country. In that time, amid the routine of production, thousands upon thousands of complex designs have had to be worked out for our customers. Result: a thoroughly seasoned background in a relatively new industry!

"Waterbury Plastics" includes one or all of these services:

DESIGNING
ENGINEERING
MOLD MAKING
MOLDING
ASSEMBLING

Please contact us as far ahead of the need as possible. Tell us what's on your mind, submitting blue prints and exact specifications so far as possible. You will hear from us promptly.

Waterbury Plastics
THE WATERBURY BUTTON CO.
WATERBURY, CONN., U. S. A.
WBCO
EST. 1812

ASSAULT BOATS *for example*

Special cold-forged metal parts for assault boats are made on equipment used regularly in the manufacture of Hassall special nails, rivets and screws. Thousands of similar examples.

Decimal Equivalents Chart FREE!

Accurate to four places. Printed in three colors for maximum legibility. Avoids errors. Saves time. No cost. No obligation.

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Established 1850
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SPECIAL NAILS RIVETS SCREWS
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Fast Finishing of Plastics and Metal

using the 3-M METHOD

When plastic and metal are combined in an article the 3-M METHOD offers a *fast* way of finishing both materials. Gates, sprues and mould marks are removed from the plastic without dust and without danger of burning or plastic flow. Burrs and tool marks are removed from the metal quickly and smoothly, without danger of wild scratches. Finishing time is kept at rock-bottom and final results speak for themselves. If you are not already using the 3-M METHOD to speed production, mail the coupon today for complete information on this practical finishing process.

Gentlemen: MPL 843
Please send me a FREE copy of your booklet on the 3-M Grinding and Finishing METHOD.
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SAINT PAUL 6, MINNESOTA

Protective

Reflective

PEARL ESSENCE

Intensifies Luminescence

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Non-Priority Unlimited Quantities

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PLASTIC MOLDS

Since 1918 leading molders have recognized this firm as the outstanding specialists in the manufacturing of molds for plastic materials, in die-sinking, engraving and hydraulic hobbing. (Capacity 2500 tons.)

Our plant is Keller, Gorton & Blanchard equipped for the most economical and speedy production of superior molds.

Place your problems in the hands of this experienced, well recognized and financially responsible concern.

NEWARK DIE COMPANY, Inc.
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TELEPHONE MARKET 2-3772
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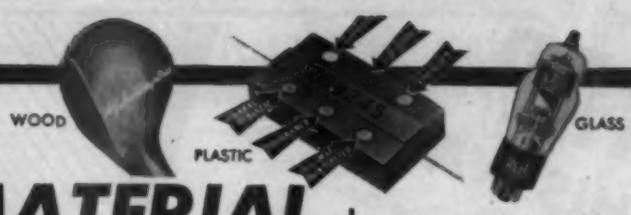
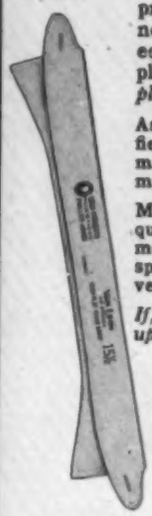


MATERIAL does not matter —when it comes to MARKING

TEXTILES



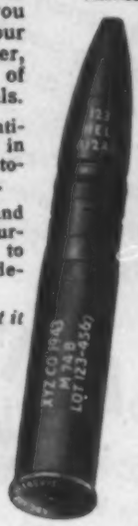
Putting your name or trade mark on articles of post war production may, because of material changes, bring to you new problems. They are not problems to us because our equipment is now being used to mark, identify or number, plain or in multiple colors — war production items of *plastics, metals, fabrics, paper,* and many other materials.

Assembly is facilitated by small part marking, sources are identified by code or other marking, step processing keyed, and in many other ways Markem equipment, synchronized to automatic speed handling, is serving on the war production line.

Markem equipment is versatile and adaptable to frequent and quick changes. Material, surface or contour present no insurmountable difficulties. Markem equipment is engineered to special needs and Markem service includes the laboratory development of inks to meet every requirement.

If, for present or future use, you have a marking problem, put it up to MARKEM. Ask for Bulletin M8.

METALS



PAPER

MARKEM
MACHINE COMPANY
KEENE N. H.

BOXES

PRECISION BUILT PRODUCTION MACHINES FOR INDUSTRIAL MARKING

MARKEM
Variable Designation
MARKING MACHINES

BOXES, LABELS, TAGS, ENVELOPES. Easy-to-operate Markem Machines print them with trademark and specification imprints, quickly, easily and inexpensively. Print boxes packed or empty. Labels, loose or on the box. Materials may be paper, boxboard, cardboard, fibre, wax paper or plastic. Also glassine envelopes.

TICKETS, TAGS, LABELS from CONTINUOUS ROLLS, one or two colors; cut-off or perforated; round or square corners; gummed or ungummed stock. Quantity may be automatically controlled. Paper, cloth, fibre, parchment or plastic.

COLLARS, SOCKS, STOCKINGS, SHIRTS, SHOE LININGS and all that myriad of large, hard-to-handle pieces of textiles, leathers and synthetics are marked in necessary detail and trademarked — all with special process Markem inks which assure legibility and durability of impression. Color possibilities unlimited.

GLASS, METAL, WOOD, PLASTICS, PAINTED SURFACES, RUBBER SHEETS —even ABRASIVES! There are Markem machines to trademark, decorate, size-mark, part-mark and do all other stampings on these products in the most approved Markem manner.

SHAPE AND SUBSTANCE PRESENT NO UNSOLVED PROBLEMS! There's a Markem machine to identify or decorate every part or product known to industry. And out of the Markem laboratories come special process inks, rotatable type wheels, special type bars or master printing plates so that Markem is the only source of supply you need for marking machines, devices and supplementary materials.

Tell us today, what you want to mark and how you want to mark it. Send for catalog M8

MARKEM MACHINE COMPANY
KEENE, NEW HAMPSHIRE

MOLDING

in all commercial plastics

...IS OUR BUSINESS!

There's no application too imaginative, no technical problem too tough for our molding service to handle—and come up with successful moldings. We work in thermoplastics, thermosetting plastics and cold-molded materials, by injection, compression and cold-molding methods. We advise you from more than two decades of successful experience in design and production.

PLASTIC MOLDING
CORPORATION
SANDY HOOK, CONN.

MODERN FRENCH OIL
Presses for Molding Modern Plastics

● For accuracy, speed and economical operation that brings increased profits turn to French Oil Hydraulic Presses, the choice of leading plastic molders. Complete self-contained presses with automatic time control that is instantly adjustable. Dependable, modern French Oil presses in sizes up to 1500 tons are the choice of leading plastic molders. Consult French Oil engineers or write for catalog.

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(HYDRAULIC PRESS DIVISION)
PIQUA OHIO U.S.A.

Plastics SCRAP WILL HELP WIN THIS WAR

Plastics are strategic materials—we make it our specialty to conserve them by salvaging all scrap and rejects.
We sell reground molding materials of all kinds and colors to substitute and save virgin molding powder.
We buy scrap and rejects at fair prices and guarantee grinding if desired.
Complete custom service: We regrind, remove all metals, sift and separate, and reclaim contaminated plastics materials.
Cellulose Acetate, Butyrate, Polystyrene, Methyl Methacrylate, Vinyl Resins, etc.

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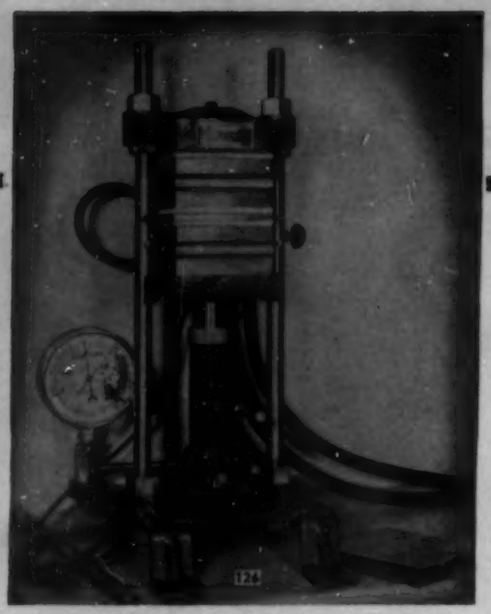

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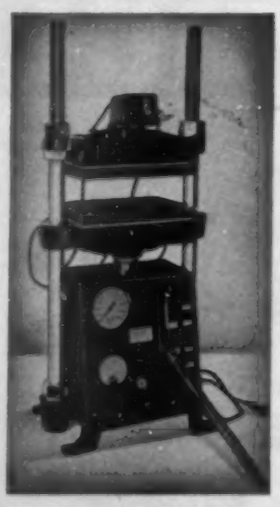

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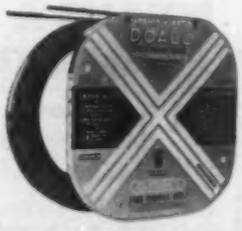

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(Continued on next page)

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